THE IMPACT OF DEMOCRATIZATION ON INFORMATION AND COMMUNICATION TECHNOLOGY PENETRATION

A Thesis

Presented to the Faculty

of Economics and Politics programme at ISM University of Management and Economics

in Partial Fulfilment of Requirements for the Degree of

Bachelor of Economics

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May 2017

Vilnius

Palubinskaitė, Justė. *The Impact of Democratization on Information and Communication Technology Penetration*: [Manuscript]: Bachelor Thesis: Economics and Politics. Vilnius, ISM University of Management and Economics, 2017.

Summary

Thesis focuses on analysing determinants contributing to disparities in information and communication technology (ICT) penetration levels among sample countries. Majority of research in the field has largely scrutinized socio-economic explanations, yet this study draws close attention to political predictor – democracy level. The proposed hypothesis suggests non-democratic regimes having lower levels of ICT diffusion. Hypothesis is decomposed into two secondary ones to account for effects on communications and IT separately. The causal mechanisms in the study rely on arguments of enhanced public sphere, mobilization and improved transparency. Empirical testing is based on fixed and random-effects panel data analyses of 34 economies for the time frame of 1990-2015. The results obtained imply partial rejection of the main hypothesis and indicate democracies having significantly higher levels of communication technology penetration, whereas the effect on information technology is inconclusive. Overall, the study advances existing research on technology divide by highlighting the importance of political determinant – democratization.

Keywords: information and communication technology, democratization, digital divide, digital dictator’s dilemma.

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Introduction

An underlying relationship between democratization and information and communication technology (hereafter, ICT) penetration is examined in this Thesis. Since 2000 the population of internet users worldwide has increased more than 6 times with 43.9% of world's population being users in 2015 (World Bank, 2017a). United Nations International Telecommunications Union data on other ICT indicators echo the positively sloping trend, suggesting increasing global access and use (UN ITU, 2016). The emergence of such technologies has dramatically shifted the way of information transfer, business environment and individual communication (Norris, 2001). Academic literature describes ICT as a driving force of productivity and economic growth, contributor to the knowledge economy as well as responsible for social progress as facilitator of networks (Cardona, Kretschmer & Strobel, 2013; Singh, 2013; Kerr, 2014; Kaur & Singh, 2016).

Regardless of positive implications of booming ICT access and use, technology diffusion nonetheless appears heterogeneous within and among economies and constitutes the phenomenon known as "the digital divide" (Selwyn, 2004; Min, 2010). Understanding the barriers to and facilitators of ICT penetration could assist on effective policy creation, thus help reap the benefits of economic growth for the countries currently worse-off (Skaletsky, Galliers, Houghton & Soremekun, 2016). Scholars in the field have distinguished variety of socio-economic predictors of differing ICT diffusion, predominantly focusing on economic and demographic determinants with rather limited emphasis on political (regulatory) factors both conceptually and empirically (Caselli & Coleman, 2001; Baliamoune-Lutz, 2003; Chinn & Fairlie, 2007; Wunnawa & Leiter, 2009; Guerrieri et al., 2011). For this reason this the link between democracy level and ICT penetration rates is examined in the Thesis.

Problem area of the study is predominantly the analysis of factors contributing to the "digital divide". Inspiration behind the study area lies within my internship at Danske Bank

Global Services Lithuania in MobilePay team. Approaching growing demand for mobile payment solutions within Denmark since 2013 has raised questions of why some technology solutions are implemented in particular economies and societies and what may constitute to ICT-friendly environment.

This study aims at testing whether political determinant of democratization is relevant to account for differing ICT levels. The logic behind such relationship is based on Digital Dictator's Dilemma and three models of ICT intervention within political system. Firstly, increased penetration of ICT makes it easier to access information and interact, thus may foster new meaning formation and have influence on political decision making. Also, ICT platforms may be tools for discussing, documenting and updating on salient issues. Lastly, ICT may help citizens to organize, coordinate and publicize their demands. These assumptions suggest that society may become more difficult to manage for authoritarian governments. Thus, the main hypothesis of democracies having higher levels of ICT penetration arises. Two secondary hypotheses differentiate between effects on communication technologies and information technology (IT).

Thesis is divided into three main chapters: Chapter 1 is the literature review on ICT penetration – potential benefits of relatively high ICT access and use are described in light of barriers to penetration; Chapter 2 examines causal mechanism between democratization and ICT penetration, whereas the Chapter 3 is the empirical testing of proposed hypotheses together with limitations and perspectives for future research.

The findings concerning communications models suggest that higher democracy levels are associated with higher fixed telephone and cellphone penetration rates (failing to reject the hypothesis concerning communications). The corresponding findings on IT in terms of internet subscriptions and users indicate having no effect. Overall, the main hypothesis is partially rejected. In addition, the study echoes previous literature as gross national per capita

income and financial liberalization appear as significant determinants of all ICT indicators. The ambiguous effect of democratization on internet use and access may refer to self-censorship and efficient internet content filtering within non-democracies.

The study improves the knowledge on non-socioeconomic predictors of ICT diffusion thus advancing the academic field of research - the “digital divide”. Within the scope of the Thesis sample, the democracy level appears to partially influence the growing gap between ICT access and use.

1. Information and Communication Technology

This chapter is the literature review of the causes and effects of different levels of ICT penetration. First of all, the definition of ICT is provided together with the relevance of such technologies on a global scale. Further, the variation of ICT levels among various countries is demonstrated and explained. Next is the section where the outcomes of ICT penetration in terms of productivity, economic growth, employment and to some extent e-government are analyzed. Lastly, facilitating mechanisms of ICT access and use are reviewed together with the barriers to it.

1.1. ICT: Definition, Relevance and Variance

1.1.1. Definition of ICT. Organization of Economic Co-Operation and Development (OECD) provides the definition of ICT sector as following: “combination of manufacturing and services industries that capture, transmit and display data and information electronically” (OECD, 2002, p. 81). In the context of this Thesis ICT is perceived in terms of economy as the driving force of productivity and economic growth and in terms of social impact as the facilitator of networking effects.

1.1.2. Relevance of ICT. ICT penetration is of great relevance to development as the diffusion of ICT and barriers to it were shown to have implications on economic growth and productivity levels among developed and developing economies (Becchetti & Adriani, 2005; Papaioannou & Dimels, 2007; Moshiri, 2016). ICT prevalence is also associated with the research areas such as the “digital divide”, “the knowledge economy” and spillover effects, which are analyzed in greater detail in the following subsections.

1.1.2.1. The “Digital divide”. The phenomenon of digital divide refers to disparities in ICT development among and within countries and the increasingly apparent gap between the haves and have-nots of ICT tools and skills (World Economic Forum, 2015; UN International Communication Union (ITU), 2016). Digital divide brings up a crucial socio-

economic issue because disadvantaged individuals, societies or countries experience further marginalization by being unable to keep up with the digital revolution and fully exploit its potential (Selwyn, 2004; Min, 2010). The theoretical and empirical examinations of causes and effects of the digital divide are therefore essential for minimizing the information and technology gap, alleviating inequality and contributing to societal improvements and economic growth.

1.1.2.2. The knowledge economy. The knowledge-based economy is an economy where the competences for knowledge creation, application and transfer are present and knowledge is considered as the basis for prosperity, growth and labour recruitment (Kaur & Singh, 2016). Knowledge aspect of economic growth is an integral part of global modern development making it is essential to promote strategic goals into that direction for countries falling behind the digital trends (Vinnychuk, Skrashchuk & Vinnychuk, 2014). Due to investments into ICT significant economic and social advancements prevailed in developed states paving an exemplary model of efficient use and favorable environment for further economic growth (Vinnychuk et al., 2014; Kaur & Singh, 2016). Approaching ICT as the mechanism through which knowledge could be transferred is straightforward, however, understanding how to make such facilitation efficient is necessary towards development within and among economies. Furthermore, strategic goals, policymaking and structural reforms (generally, the economic and social environment) are fundamental parts of moving towards benefiting from ICT.

1.1.2.3. The spillover effects. Spillovers are defined as positive externalities, which generate returns greater than initial investment and consequently influence other economic sectors (Jaffe, Trajtenberg & Henderson, 1993, as cited in Kretschmer, 2012, p. 8). Spillovers could exist on firm, industry, country and international levels (Moshiri, 2015). Applying the logic to international level, a rise in investments in ICT in a particular country could lead to

productivity gains and growth there and transmit to other ones via trade relations, or FDI (Keller, 2009; Moshiri, 2015). Moreover, ICT could facilitate social spillover effects via greater and more active citizen participation and involvement in policymaking.

1.1.3. Variance in ICT Penetration Rates. As already mentioned in the previous section, ICT penetration is important for inclusive economic growth, country development and shift towards the knowledge economy. Nonetheless, the variance in ICT diffusion levels exists in terms of geographic regions, country development levels and within societies prevails and is explored in more depth further.

1.1.3.1. Geographic regions. Based on International Telecommunication Union (ITU) "Measuring the Information Society Report 2016" the disparities in ICT penetration levels among geographic regions are significant with the lowest levels in Africa (lowest values include 1.1 subscribers of fixed telephone and 0.5 of fixed broadband per 100 inhabitants), Arab States and Asia-Pacific, illustrating the presence digital divide (see Figure 1). Europe,

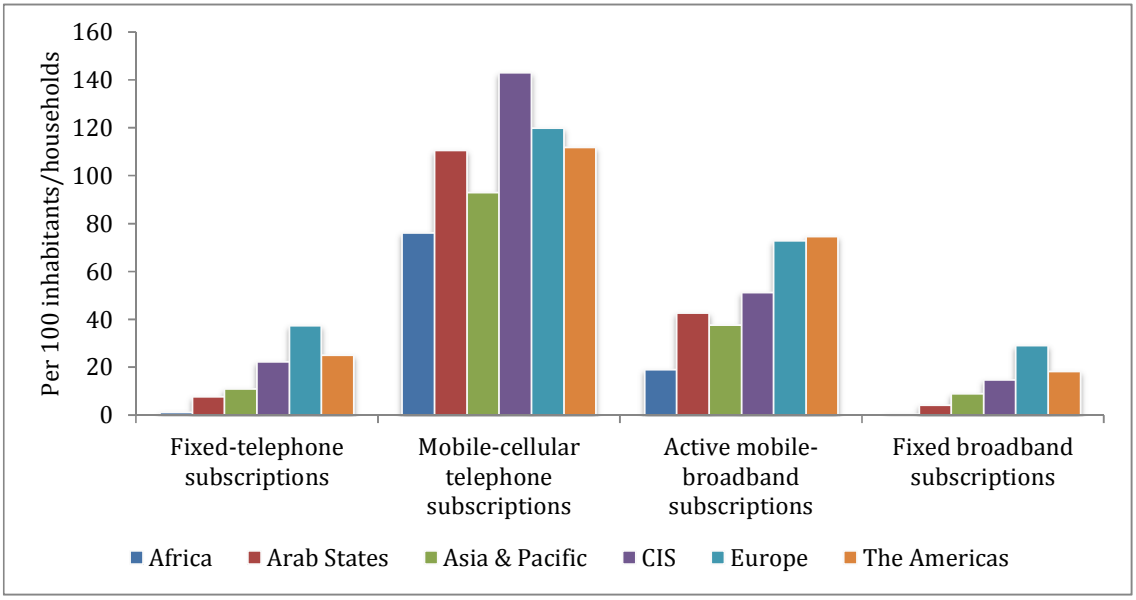

Figure 1. ICT Penetration Variation: Geographic Regions, 2015. Source: ITU, 2015. Compiled by author.

Americas and CIS, largely comprised of developed and middle-income developing economies, have the highest rates among ICT measurement criteria. Interestingly, penetration rates appear to be the highest in mobile cellular subscriptions among all regions considered, where only Africa and Asia-Pacific fall below 100 subscriptions per 100 inhabitants with the corresponding values of 76.2 and 93.

1.1.3.2. Level of development. ICT penetration based on the level of economic development is consistent with regional trends. From Figure 2, we can see the obvious gap between developed and developing economies, especially in the values of Active mobile broadband subscriptions with the difference of 51.8 subscriptions per 100 people. Mobile-cellular phones appear as the most widely spread ICT good with 93 subscriptions in developing countries and 125.7 in developed ones calculated per 100 inhabitants or households.

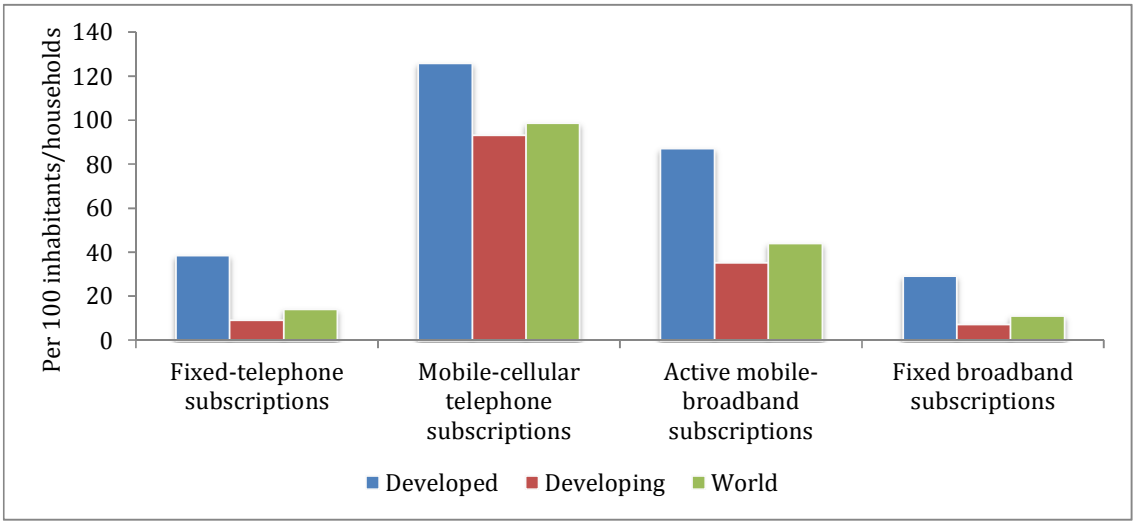

Figure 2. ICT Penetration Variation: Level of Development, 2015. Source: ITU (2015). Compiled by author.

1.1.3.3. Socio-economic status. Socio-economic status was proven to have an effect on variance in terms of access and use of ICT in addition to geographic location and development (Warf, 2001; Selwyn, 2004; Min, 2010). Selwyn (2004) distinguishes that the patterns of access and use of ICT appear with regards to income (richer parts of society have

more opportunities to use ICT), gender (greater proportion of men than women report having access to ICT), age (ICT access and use is correlated with age), household size, education level or even ethnicity. Such socio-economic stratification implies that the digital divide a phenomenon not only among countries but also within societies.

1.2. The Effects of ICT Prevalence

Further subsections examine the relevance and outcomes of ICT penetration to the economy more extensively. The potential outcomes of expansion in ICT include economic growth, improved productivity, and changes in employment. Lastly, brief overview of ICT facilitated e-government is provided.

1.2.1. Economic Growth and Productivity. Productivity refers to the efficiency of output produced based on the inputs used in the process. The effect of input and output efficiency could be examined at both microeconomic and macroeconomic levels. The latter is used when assessing the prosperity of the national economy and therefore considered in the Thesis.

The vast majority of the literature is attributed to determining the drivers of the productivity growth, as the pace of growth differs significantly among countries. Since the mid-1990s much of the growth in productivity levels was considered due to investments into ICTs and generated by industries with extensive use and production of ICT (Cardona, et al., 2013). Moreover, ICT is an exceptional case of high-tech because it enables further innovations via spillover effects, as the companies producing ICT may share their efficiency (productivity) gains with the ones using ICT extensively.

In theory, productivity growth is associated with wage increase, thus is essential for the standard of living of an economy (Cardona, 2013). In this context ICT acts as an influential driver of productivity because it contributes to input factor improvement – production quality, the production process, worker training and overall knowledge

accumulation. The more efficiently ICT input factors are used, the greater outcome is generated from initial investment into workers and technology, fostering improvement in standards of living (Cardona et al., 2013).

1.2.1.1. Cobb-Douglas production function. The most common representation of measuring the productivity growth is the Cobb-Douglas production function shown below:

$$Y = A \times K^{\alpha} \times L^{\beta}.$$

In the equation *Y* refers to aggregate output, while *K* and *L* represent capital and labour invested and required for production. The coefficients α and β are capital and labour (factor input) elasticities, which demonstrate, how a 1% rise in input factor affects the percentage increase in output. Lastly, the value *A* is interpreted as technological progress (or the state of technology) and is referred to as total factor productivity (TFP) growing at an exogenous rate (Quah, 2001; Cardona et al., 2013).

1.2.1.2. ICT productivity estimation. As Cobb-Douglas is only a starting point of productivity estimation, different approach is required when accounting for the ICT-driven productivity growth. Therefore, building on the foundations of Cobb-Douglas, the following econometric productivity model accounting for ICT is considered and used by researchers in estimations (Brynjolfsson & Hitt, 2003, as cited in Cardona et al., 2013, p. 114):

$$lnY_{it} = \beta_1 lnC_{it} + \beta_2 lnK_{it} + \beta_3 L_{it} + X + \epsilon_{it}.$$

Here *Y* refers to aggregate output, *C* and *K* are respectively, ICT and non-ICT capital, *L* refers to input of labour, while X is control variables. Indices of *i* and *t* indicate the units of analysis – the former reflects the country, whereas the latter stands for the time period. The coefficient β_1 may be interpreted as the "output elasticity of ICT" (Cardona, et al., 2013, p. 114).

Further reflection on productivity needs to emphasize ICT characteristics of the general-purpose technology (GPT). GPT is defined as changes that affect households, businesses and the whole economy and described best by examples, such as electricity and information technologies (Jovanovic & Rousseau, 2005). Many researchers consider ICT as general-purpose technology due to its functions to store and transmit information (knowledge) and ability to enable other industries to perform more efficiently. Using the GPT hypothesis, ICT-capital as input to production function is not limited to capital deepening effects, where substitution of particular input channel to ICT-driven input exists as ICT products become relatively cheaper (Cardona et al., 2013; Moshiri, 2016). Additionally, productivity increase could as well be influenced by spillover mechanisms, whether internal (worker trainings due to extensive ICT use, computerization) or external (network characteristics, enhanced information).

Great part of empirical studies have found positive and significant effects of ICT on productivity, however, results differ depending on methodology applied (Becchetti & Adriani, 2005; Papaioannou & Dimelis, 2007; Cardona et al., 2013). This suggests that the "digital divide" may alter country productivity levels, thus, the growth. For extensive overview of empirical findings related to ICT and productivity refer to Cardona et al. (2013), as the focus of the Thesis does not require in-depth review.

1.2.2. Employment and Labour Demand. Freeman (2002) distinguishes three areas where effects of ICT on the labour market are perceived: firstly, in terms of pay per hour and labour (skillset) demand, secondly, in changes in recruitment practices, which shift online, and lastly, in differences that appear in functioning of the trade unions. The potential outcomes and empirical findings due to digitalized improvements are described hereafter.

1.2.2.1. Demand for labour and wages. The logic behind ICT use and wages is based on disequilibrium model, where technologies increase the demand for individuals using ICT

tools effectively, thus in short term forming premium for such workers (Freeman, 2002). As ICT use becomes universal, the effect should become insignificant. Indeed, positive association between computerization of workplace and demand shift was found in empirical studies, resulting in changes in quantity and price for labour, therefore higher pay per hour (Autor, Krueger & Katz, 1998; Freeman, 2002). The consequential study of the computer and internet use has suggested significant positive effect on the level of wages, despite the increasing numbers of internet and computer users, no evidence was found on premium decline in time (Freeman, 2002). Another study by Michaels, Natraj & Reenen (2010) has examined the "polarization" of worker skills demand due to introduction of ICT in OECD countries. The proposed hypothesis stated that higher ICT penetration should act in favour of highly skilled workers and against middle educated individuals due to automatization of routine tasks. Using the skill share regressions, the authors found support for their hypothesis. This suggests a directional change not limited to quantity of labour but as well to quality.

1.2.2.2. Recruitment practices. A second area of ICT-driven change is in the new methods of job seeking and recruitment, when ICT platforms provide low costs of transaction, timely results and also increase the chances of matching the skillset of an employee and vacancies offered (Freeman, 2002). The additional benefit of online job search is that job posts include positions for great variety of work and the benefits are not limited to only high-tech sectors or highly-skilled workers, nevertheless, such argument requires sufficient access and use of internet – infrastructure and the skillset for job search needs to be present. Societies with lower levels of ICT penetration may fail to capitalize the aforementioned benefits and stick to traditional, geographically bounded and network-based job search, having potentially higher transaction costs in obtaining information (Freeman, 2002).

1.2.2.3. Trade unions. Despite the urge of firms to adopt ICT, in terms of computerization and conducting business online, trade unions have been slow and conservative towards internet as a medium (Freeman, 2002; Ward & Lusoli, 2003; Lucio & Walker, 2005). Some analysts argue that ICT spread should not be bypassed but rather acknowledged and put into use for the sake of greater online presence and restructuring whereas others challenge the idea and argue for the falling importance of representative organizations due to the progress of ICT (Ward & Lusoli, 2003). The first position constitutes "modernization" and "democratization" arguments. "Modernization" argument suggests that ICT encourages unions to exploit ICT tools, thus, transforming traditional practices – administrative tasks, provide online service and assistance, better targeting at new members and overall contribute to a more contemporary image. Meanwhile, "democratization" explains ICT as having potential in terms of member mobilization, decentralization and more far-reaching campaigning (Ward & Lusoli, 2003). The research paper by Freeman (2002) echoes the same ideas of Ward and Lusoli (2002) by distinguishing five scenarios of union response towards the introduction of ICT and potential beneficial use.

Rationale behind "customized service" scenario highlights reduction in transactions costs of obtaining union-related materials on worker rights and internet-based contact possibility, which would alternatively be too costly (Freeman, 2002). Examples of successful practices of ICT facilitated union activities include provision of information involving work-related risks, discrimination issues or general overview of union activities for uninformed via hot lines or e-mail alerts. Another scenario, referred to as "new internationalism", explains how ICT could help solidarity and mobilization spread among members of the union and workers in general beyond national borders (Lucio & Walker, 2005). New medium of communication, such as internet, could provide more up-to-date information on global workers strikes rather than traditional communication channels. Meanwhile, "cyber dispute"

scenario suggests that ICT platforms such as social media may become a great channel for expressing union demands, settling disputes and bargaining with the firms (Freeman, 2002). Society of Professional Engineering Employees in Aerospace (SPEEA), which posted the updates on their bargains with Boeing online and received enormous support and publicity, could be considered as one of the most prominent success stories. The fourth scenario of "cyber-organizing" implies that online presence could be significant alternative in cases where union awareness is low (Freeman, 2002; Lucio & Walker, 2005). Such way of operating includes attaining the membership and discussing issues at low cost online and puts forward the Web as the primary medium for union activities. "Union democracy" scenario being the last one focuses on restructuring decision-making in terms of decentralization (Freeman, 2002; Ward & Lusoli, 2003). This would support ordinary member participation in the trade union rather than limit it to hierarchical or elitist control.

Regarding the negative impact of ICT to traditional institutions, "erosion" could take place (Ward & Lusoli, 2003). Ward and Lusoli (2003) summarize the views as follows: firstly, individualistic character of modern societies could diminish the need of collective bargaining; moreover, new social movement forms could become more attractive and exploit ICT more effectively as conventional nature of unions shows scepticism towards such advancements; lastly, on a more radical note, people engagement could switch to more direct forms of representation. Naturally, the prospects of full "erosion" due to ICT with no representation of intermediaries, such as trade unions, are vague.

1.2.3. E-government. A rise in ICT penetration has given stimulus for majority of countries to integrate such technologies in governments, now known as e-governments. The concept of e-government has varying definitions but the principal features are more efficient and timely provision of government services together with easier access to public information and closer citizen-to-government interaction due to the use of technology (Basu, 2004; Gupta,

Dasgupta & Gupta, 2008). Digital government is not limited to straightforward need for online existence but more importantly to greater interactivity and effective relationship management between businesses, individuals and the government (Basu, 2004). As a consequence, greater levels of trust and more positive outlook to government are perceived (Tolbert & Mossberger (2006) as cited in Gupta et al., 2008, 141).

Furthermore, considerable amount of literature has focused on ICT as means to promote transparency through e-government implementation with the emphasis on best practices and strategies for the developing countries (Gupta et al., 2008; Shim & Eom, 2009; Bertot, Jaeger & Grimes, 2010). The main ideas among the studies are that, firstly, ICT may reduce the probability of misuse of power by public officials, secondly, technology may assist transparency promotion by the government through public information access and distribution and, lastly, it may set an environment for greater social capital with greater interactivity (Shim & Eom, 2009; Bertot et al., 2010). ICT and government interrelation, touching upon the issue of transparency, is examined in more detail in Chapter 2 of the Thesis.

1.3. Determinants of ICT Penetration Levels

After the review of ICT-driven outcomes and relevance, the barriers to and facilitators of ICT access and use among the economies have to be emphasized. Examination of ICT diffusion determinants may help explain the variation in access and use levels as well as provide implications for further exploitation of ICT-led productivity growth and other benefits. The following subsections consider socio-economic predictors highlighted in previous studies.

1.3.1. Foreign Direct Investment. Incoming foreign direct investment (FDI) may result in increased access to technology by local, recipient firms, implementation of better managerial practices and share of knowledge and expertise in the field (Baliamoune-Lutz,

2003). The effects of increased FDI may not be limited to the direct effects – more technology, as suggested, but also generate spillovers – knowledge sharing, that potentially affects other local firms. The spillover could occur in at least three ways. The host country firms may emulate technologies from foreign corporations (referred to as imitation or demonstration effect) or rehire workers trained by foreign branches (labour mobility effect), thus increasing their efficiency (Javorcik & Spatareanu, 2005; Keller, 2009). Also, the mere entry of the foreign capital firms may increase the competition locally (known as competition effect) resulting in stimulus for seeking efficiency and new technology (Blomström & Kokko, 1998 as cited in Javorcik & Spatareanu, 2005, p. 5).

FDI relevance is not limited to being a channel of technology flow but may also involve local government resource allocation (e.g. public spending on better infrastructure) towards attraction of foreign multinational affiliates (Javorcik & Spatareanu, 2005; Kosack & Tobin, 2006; Keller, 2009). Such practices may either indirectly contribute to growth and positive externalities or have negative consequences and distort the market. As mentioned, foreign companies may foster competition. However, if foreign affiliates are overly advantaged, local firms in the same industry may not be able to compete. Moreover, subsidies for foreign capitalists may alternatively attract FDI in industries where local firms have no comparative advantage and therefore produce inefficiency (Kosack & Tobin, 2006).

Despite the fact that spillover effects contribute to the greater theoretical understanding of the processes of FDI spread, they are out of scope of data analysis in the Thesis. The proposed relationship between FDI and ICT is positive – more inward FDI should mean greater ICT penetration.

1.3.2. Trade Liberalization. Another trade-related potential determinant of ICT penetration levels is trade liberalization. It may be argued that in case of East-Asian economies, ICT spread may be a consequence of learning-by-exporting practices (Jussawalla,

1999, as cited in Baliamoune Lutz, 2003, p. 156). The concept of learning-by-exporting refers to exporting firm's adoption of particular ICTs based on foreign technical expertise (Keller, 2009). Moreover, computerized solutions of communication might also bring efficiency when conducting business internationally, thus require sufficient ICT indicators', such as computer and internet, access and use (Baliamoune-Lutz, 2003). This is assumed as direct effect of trade liberalization. In terms of imports, the imported production may increase the need for presence of some ICT or ICT may be integrated in imported good (Baliamoune-Lutz, 2003).

Based on theoretical grounds, the relationship between trade openness and ICT diffusion is expected to be positive. Previous empirical studies, however, suggest inconclusive results (Guerrieri, Luciani & Meliciani, 2011). Whereas findings by Caselli and Colleman (2001) and Baliamoune-Lutz (2003) yield significant and positive effect, Chinn and Fairlie (2006) find no significance.

1.3.3. Income. Income (per capita) is considered as the most important determinant of ICT adoption and use in many studies (Caselli & Coleman, 2001; Kiiski & Pohjola, 2001; Baliamoune-Lutz, 2003; Chinn & Fairlie, 2006; Wunnava & Leiter, 2009). The variable comes from the arguments in literature that digital divide is primarily caused by differences in gross national income (Guerrieri et al., 2011). For this reason GNI per capita is accounted for in all econometric studies on ICT spread, access, use and etc. (Wunnava & Leiter, 2009). A positive relationship is expected, as in countries with lower levels of GNI the income criteria should as a barrier of ICT diffusion and vice versa - higher levels should facilitate adoption.

1.3.4. Financial Liberalization. Variation in ICT penetration rates among the countries may be explained by the divergent liberalization of banking sector (Baliamoune-Lutz, 2003; Chinn & Fairlie, 2010). The argument is that banks are usually the pioneers and the main benefit and revenue seekers of ICT adoption, especially taking into account

developing economies (Baliamoune-Lutz, 2003; Agboola, 2007). Indeed, Agboola (2007) has found increased competition and efficiency in banking industry of Nigeria due to extensive adoption of ICT. Therefore it is logical to assume that as banking sector introduces more services online and offers more up-to-date information, which customers value, the penetration of mobile cellular phones or internet in general should increase

Baliamoune-Lutz (2003) using the broad money (% GDP) as a proxy for financial liberalization implies no significant effect on ICT diffusion. However, this may be due to the framework of the study, which considers the diffusion for relatively short time period 1998-2000. Study by Chinn and Fairlie (2006), measuring financial liberalization as access to credit, demonstrate large and positive effect supported by statistical significance. Overall, the anticipated relationship should be positive with increased ICT access and use due to financial sector development.

1.3.5. Pricing. Cost of fixed-telephone subscriptions should intuitively have an effect on fixed-telephone and/or Internet usage rates. This study, however, does not consider analyzing pricing effects as following the example of Baliamoune-Lutz (2003), Guerrieri et al. (2011) and in contrast to Chinn & Fairlie (2006). Previous scholars have used monthly fixed-telephone subscription charges as a proxy to account for the cost of internet pretty widely, however, not all of those have shown significant results (Chinn & Fairlie, 2006). Guerrieri et al. (2011) summarizes that there is no common conclusion in the literature on whether pricing should be used as a predictor of differing ICT penetration levels. In general, lower price should encourage greater ICT use.

1.3.6. Infrastructure. Of the studies on the “digital divide” that have to some extent included the infrastructure variables, the vast majority had considered “the number of telephone lines per 100 inhabitants” as a proxy for internet spread (Kiiski & Pohjola, 2001; Chinn & Fairlie, 2006; Wunnava & Leiter, 2009). Wunnava and Leiter (2009) criticize such

approach and conclude that importance of traditional telecommunication infrastructure should go down as the popularity of broadband and wireless technologies grows. Broadband connection advancements allow for using one telephone line to provide internet for a whole network of computers (compared to one telephone line to one computer in the past), also, there are wireless solutions, with no phone lines.[1] This suggests that mismatch in the effects may appear and such predictor may be unreliable.[2] Some studies choose not controlling for infrastructure altogether (Kiiski & Pohjola, 2001; Baliamoune-Lutz, 2003).

1.3.5. Education and Literacy. Many studies include measures of education (tertiary education, literacy rates, years of schooling, etc.) as potential determinants of ICT penetration rates. Conventional wisdom suggests that text-based communication via internet requires a user to be literate, whereas the lack of both, education and literacy, may hinder the spread of ICT within the country. Some studies confirm the positive and statistically significant effect (Wunnava & Leiter, 2009; Skaletsky, et al., 2016), others find such predictor as statistically insignificant (Kiiski & Pohjola, 2001; Chinn & Fairlie, 2006; Baliamoune-Lutz, 2003). Despite differing results, majority of reviewed studies unconditionally control for some measure of education.

1.3.6. Additional Socio-economic Determinants. Some studies in the past have considered additional socio-economic predictors with empirical findings yielding

[1] Wunnava and Leiter (2009) in addition suggest that advanced solutions might be a phenomenon of developed countries only and do not use the aforementioned proxy within their sample including both developed and developing countries.

[2] Fixed-broadband subscription rate and Internet User rate are used as dependent variables in few of the models in Data Analysis part (Chapter 3). In both case scenarios concerns are present and misestimating may arise due to inconclusive effect of traditional telecommunication infrastructure on ICT penetration.

inconclusive or insignificant results. English language proficiency was considered as a potential explanatory variable due to perceptions of it as having the greatest internet presence, however, empirical findings showed no support (Caselli & Coleman, 2001; Skaletsky et al., 2016). Some authors to account for effects on ICT use include wealth distribution (inequality) (Wunnava & Leiter, 2009; Skaletsky et al., 2016). The underlying assumption is that income gaps may determine whether particular individuals can (not) afford cellphone or internet subscriptions. Yet, Baliamoune-Lutz (2003) provides an argument that the variable might appear insignificant: as ICT use is usually concentrated in non-rural areas, clusters, social ties (on behalf of families, work relations or educational institutions), ICT could act as a "spillover" in the cluster and compensate for discrepancies in wealth distribution. Thus, spatial inequality could be a better choice for a proxy.

Whereas socio-economic indicators contribute to a great part of ICT penetration determinants, many academic articles consider them as insufficient and in addition include regulatory or political ones. Further discussion of potential political predictors is in the Chapter 2 of the Thesis.

2. Democratization

Apart from socio-economic explanations of variation in ICT penetration among countries, political determinants may define the position of a particular country on the digital divide spectrum. Literature distinguishes several factors, such as political (regulatory) environment, political freedom in terms of political and civil rights, quality of political institutions and property right protection, which account for varying levels of ICT adoption and use (Caselli & Coleman, 2001; Baliamoune-Lutz, 2003; Chinn & Fairlie, 2007; Wunnawa & Leiter, 2009; Guerrieri et al., 2011). Rigid regulation may discourage ICT spread due to government control of particular economic sectors, e.g. telecommunications, also poorly developed or non-transparent governmental institutions may limit or be inefficient in developing ICT infrastructure, thus diminish its use, access and investments (Howard et al., 2009). Furthermore, the lack of political freedom may suggest lower usage rates of ICT, as communication tools as freedom of expression, are in general relatively limited or controlled in these settings. Such politically adverse environment may also discourage foreign investors or impose difficulties of local firms to import ICT goods and services.

One distinct political determinant incorporating other aspects of regulatory environment and political and civic freedoms is the regime type (or democracy level, used interchangeably further on). Therefore, democratization is considered as a matter of interest in the Thesis. In the context of this Thesis democratization is approached as the change in the level of democracy rather than regime transition (change).

2.1. Conceptualizations of Democracy

Literature on comparative politics distinguishes a few prevalent measures of the regime type together with underlying definitions. These measures include various components, conditions of democracy, allowing for operationalization of the concepts.

However, they are based on different theoretical foundations (Cheibub, Gandhi & Vreeland, 2010). In order to define the democratization concept applied in this thesis, regime type measurements are examined in more depth in subsections.

2.1.1. Democracy-Dictatorship (DD) Conceptualization. Democracy-dictatorship (DD) measure is based on conceptualization of democracies as "regimes in which governmental offices are filled as a consequence of contested elections" (Cheibub et al., 2010, p. 69). Two key terms, or the elements of definition, are of great importance – "offices" and "contestation". The former reflects a democratic system, where both executive and legislative offices are filled based on electoral outcomes and the latter defines if there is an opposition as a result of elections. Therefore, the measure is heavily based on the notion of contestation – the freedom of organized citizen action, engagement in party formation, speech and assembly. Moreover, the DD regime measurement adopts a minimalist view of democracy, as democracy rests only on institutions and their procedures (Cheibub et al., 2010; Clark, Golder & Golder, 2013). This implies that the only sufficient and necessary condition characterizing a democracy is the contested elections, where governing bodies are selected. The DD measure of the regime treats it as dichotomous, where precise and objective classification rules determine a discrete category of either democracy or dictatorship. Such coding implies objectivity, replicability and reliability in measuring the regime type (Cheibub et al., 2010; Clark et al., 2013).

2.1.2. Polity IV Conceptualization. As an alternative, Polity IV measurement of democracy is widely used and approached as an "aggregation of authority patters" (Marshall, Gurr & Jaggers, 2016; Cheibub et al., 2010). The measurement incorporates indicators of limitations on the executive authority (whether the authority is unlimited, on par with or strictly constrained by legislature) and the degree of inclusion, as a potential for political participation (whether political action is regulated, somewhat controlled or inclusive for all

given social units) (Cheibub et al., 2010; Clark et al., 2013; Marshall et al., 2016). Whereas the contestation concept is equally substantial in Polity IV as in the DD index, the inclusion dimension here constitutes a democratization element completely ignored by the DD measure. The authors construct the scores of Democracy and Autocracy and the difference of these is the overall Polity score, which illustrates where a particular country is based on the continuum of regime type (Clark et al., 2013). Such conceptualization suggests that mixed regimes may exist along the spectrum, as the regime type is not dichotomously defined. Polity IV follows a minimalist view, in line with the DD measure, as exclusively the institutions and related procedures are addressed.

2.1.3. Freedom House (FH) Conceptualization. Freedom House (FH) concept of democracy is as follows – freedom in terms of political and civil rights. Two elements capture the democratization level – political rights dimension and civil liberties dimension, which provide averaged result in an overall FH score for each considered country (Cheibub et al., 2010; Clark et al., 2013). Countries, based on the FH scoring, may be placed on the democracy-dictatorship continuum similarly to Polity IV, which allows for variation rather than binary categorization. In terms of inclusion and contestation, the FH conceptualization incorporates both of them in the methodology, much like Polity IV. However, as opposed to the two previous measures, FH follows the substantive view of democracy, as institutions are approached as not sufficient (though necessary) in representing a political regime. This in turn suggests that the emphasis should be based on the outcomes generated by institutions – provision of public goods, accountability of governments, economic equality, etc. (Cheibub et al., 2010; Clark et al., 2013). Because of the troublesome aggregation and difficulties in obtaining relevant information, the FH index is referred to as the most arbitrary, subjective, hardly replicable or valid (Cheibub et al., 2010).

2.1.4. The Economist Intelligence Unit's (EUI) Democracy Index. EIU index of democracy relies on five pillars: fairness and pluralism of election procedures, human right protection, quality of government, political engagement and, lastly, political culture in terms of legitimacy and overall democratic functioning (Kekic, 2007). The index is beneficial as it allows to differentiate and compare countries, especially developed ones (e.g. reasons behind Scandinavian countries being at the top of "full democracy", while UK and the U.S. are at the bottom of the same category). In addition, political engagement and quality of government are emphasized considerably more compared to aforementioned measures of democracy (Kekic, 2007). EIU democracy index is calculated by rating each of the categories from 0 to 10 and then averaging the score. The obtained values allow positioning countries in one of four regime types, where index score of 8 – 10 and 6 – 7.9 imply full democracies and flawed democracies, respectively; scores of 4 – 5.9 and < 4 reflect hybrid or authoritarian regimes.

2.1.5. The Concept of Democratization Applied in the Thesis. Democratization definition used in this thesis is the one provided by Polity IV. This definition incorporates authority patterns and political inclusion, which may be considered as important in affecting ICT access and use. Also, the study question requires using continuum rather than dichotomous scale of the regime type, therefore using Polity IV index appears empirically appropriate, as reflected in Data Analysis Chapter 3. An alternative of FD was considered, yet, due to questionable validity, subjectivity and other reasons considered so far, this method does not seem superior to Polity IV. The DD is not chosen due to dichotomous scale, whereas EIU democracy index lacks greater time frame.

2.2. Digital Dictator's Dilemma

The most prominent theory describing the relationship between democratization and openness or freedom of ICT is the "(digital) dictator's dilemma" – the tradeoff between sacrificing the economic benefits of ICT-driven growth by keeping the non-democratic

regime intact and committing to the knowledge economy while risking stability of dictatorial regime (Kedzie, 1997; Kerr, 2014). The conceptual framework of digital dictator's dilemma is depicted in Figure 3 below.

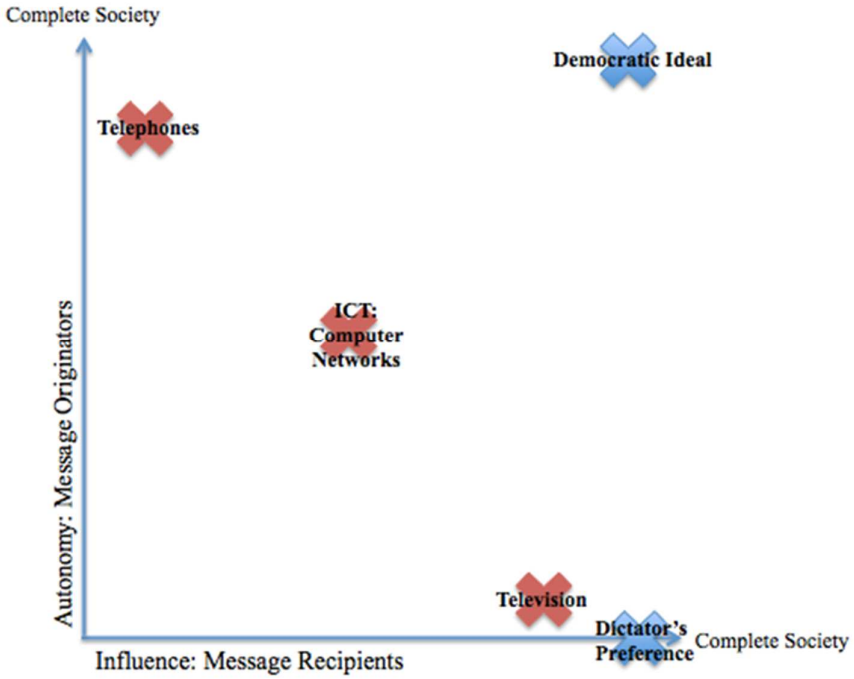

Figure 3. Communication Effect on Society. Compiled by author, based on Kedzie (1997).

The axes represent the communication recipients and originators. Traditional media, such as television (on the right bottom corner) captures vast audience, however, is influenced by constraints in terms of politics, economics and technology (Kedzie, 1997). Telephony provides users with great autonomy while it often is "one to one" communication with usually no more than one recipient. Influence grows as greater audience is able to receive information and autonomy increases as more members of society are given the opportunity to express their views. Dictator's objective is therefore to minimize autonomy of expression and maximize the influence, which is relatively simple if communication technologies move along the linear path of the axes (Kedzie, 1997). Hence, the dictator's optimum point is at the

bottom of right-hand corner, where the authority of regime dictates messages flowing to all citizens. Democratic ideal at the upper right-hand corner symbolizes a complete society where because of great autonomy and influence the exchange of ideas is present.

Introduction of computerized communication via ICT platforms contributes to economic benefits, such as productivity growth or economic development, already covered in economic policy analysis part of the thesis. However, the emerging question is whether the proposed benefits remain equally important, as growth in ICT may as well bring changes in political arena. ICT penetration in Figure 3 is shown as a connectivity tool enhancing simultaneously both – the autonomy of citizens' views expression and the influence on the messages the audience receives. Furthermore, it goes well beyond the "comfort zone" of a dictatorial regime, as increased citizen association and connectedness may become difficult to manage. Growing ICT penetration due to perceived economic opportunities in non-democratic regimes would mean moving towards more liberalized society in terms of providing citizens with access and use of ICT sources for opposing the authoritarian regulation (Kedzie, 1997).

2.3. Modeling Democratization and ICT Relationship

This section reexamines the dilemma in greater depth and provides arguments for potentially different ICT penetration levels based on existing political regimes. Several models, developed by A. Fung, H. R. Gilman and J. Shkabatur (2013), show how ICT presence may affect the public sphere, transparency, citizen mobilization and as a consequence impose a threat to non-democratic regimes or strengthen the existing democratic governance. The implications of ICT intervention in political structure are described in depth in the following sections and are considered as motivation behind the hypothesis.

2.3.1. Public Sphere Model. Digital technologies facilitate the spread of information and perform a significant role in revolutionizing the public sphere. ICT is often referred to as

empowering the far-reaching "many-to-many" communication by lowering costs of acquisition of knowledge, share and expression of views, including political ones (Diamond, 2010; Min, 2010; Fung et al., 2013; Singh, 2013).

Pre-internet society with a low level of ICT in terms of connectivity would be democratically deficient in terms of opinions expressed and messages conveyed – the content would also most likely be controlled by a few entities, the mainstream media. When the connectivity as a mechanism of ICT access and use increases – the public sphere should become more accessible and less concentrated with enhanced democratization. This increased accessibility and interaction may result in new meaning formation and influence political decision-making (Fung et al., Singh, 2013). Such transformation of public sphere is illustrated in the Figure 4.

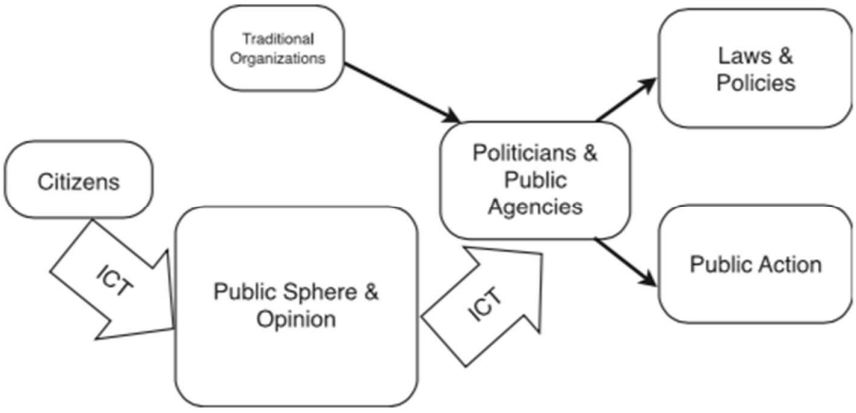

Figure 4. Public Sphere Model. Based on Fung et al. (2013).

There is an existing and valid critique claiming that ICT-driven improvements may not change the character of the public sphere. The first critique involves egalitarianism – despite the extensive content available, the individuals consume only a moderate and particular part of it, whereas the greatest amount of content is produced by a small fraction of entities, i.e. content "hierarchy" exists (Fung et al., 2013). Another critique is deliberation, as the virtual societies are prone to clustering into like-minded groups, which signals non-

existent or minor public sphere improvements in comparison to pre-ICT societies (Fung et al., 2013) Such assessment, however, is based on assumption of liberalized content and freedom of speech – the qualities of democratic societies.

The framework of the public sphere model (Figure 4) may work exceptionally well in authoritarian regimes. In non-democratic countries, where the public sphere is purposefully kept relatively small and the content is controlled or limited, the ICT spread could lead to some pro-democratic improvements and act as "liberation technology" (Norris, 2001; Fung et al., 2013; Kerr, 2014). As authoritarian governments seek to regulate media through limited outlets via ownership and monopolies, the greatest challenge arises in controlling opposition in the new media as compared to airwave – radio or television regulation (Norris, 2001; Diamond, 2010; Fung et al., 2013). This constitutes a favorable setting for online journalism as low production costs allow for opposing views expression (Norris, 2001; Diamond, 2010). Virtual social space in authoritarian regimes may come forward as a new platform for free speech in terms of unregulated, free media, therefore posing a threat to an existing regime's stability. The model, as depicted in Figure 4, should be effective and the ICT-led public sphere should become more democratic than pre-ICT as long as the authoritarian regulation over ICT is troublesome or inefficient. Aforementioned assumptions could explain why the digital networking facilitated social movements of opposition in Egypt and Tunisia, however, it may not produce similar outcomes in countries where free speech is preserved or online regulation is advanced (Fung et al., 2013).

2.3.2. Truth-Based Advocacy Model. The next model, the Truth-Based Advocacy, explains how ICT platforms act as agents of evidence documentation and may alter public opinion by putting forward salient issues and challenging the actions of current governments (Diamond, 2010). The idea behind is that ICT platforms and tools reinforce the power of truth within society and strengthen traditional activism in terms of voting and nontraditional

ways, e.g. social media channels (Fung et al., 2013). The informed society as a consequence of ICT-led credible updates on governance and politics may be able to pressure and alter

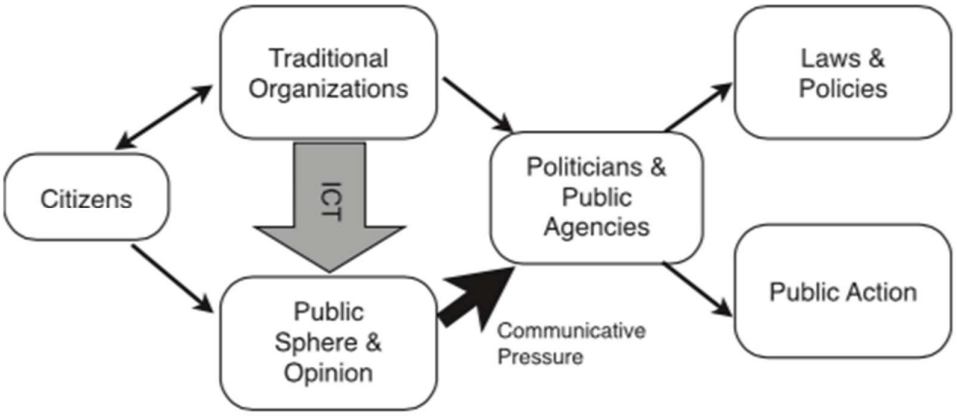

Figure 5. Truth-Based Advocacy Model. Based on Fung et al. (2013).

policy-makers' actions. The mechanism of the model is provided in Figure 5.

Facilitation of truth-based advocacy may bring incremental, non-revolutionary changes, as entrenched governmental institutions may be resistant to change. Nevertheless, ICT platforms offer a way of expression for marginalized societies and provide political education for citizens in documenting "taboo" issues of discrimination, human rights abuses, corruption, etc. For such mechanism to be effective, credible traditional organizations must commit to utilizing ICT means to spread information on issues under public pressure and deliver it in easily accessible way (Fung et al., 2013). Such assumptions reflect unwillingness for non-democratic regimes to allow free spread of ICT tools or adoption of restrictive censorship measures towards the creation of "national intranet" (Diamond, 2010).

2.3.3. Mobilization. In the last examined model ICT is perceived as a mechanism for (political) citizen mobilization. ICT networks in times of crisis may perform a critical role of helping citizens to organize, coordinate transmit information and publicize the demands, as considered by some scholars, was actually the case of Arab Spring protests in the Middle East (Kalathil & Boas, 2003; Diamond, 2010; Stepanova, 2013). Whereas the ICT have limited

direct influence on citizen movements, it is an accelerating factor of social upheaval facilitating widespread visibility of circumstances and issues. The mobilization model is depicted visually in Figure 6.

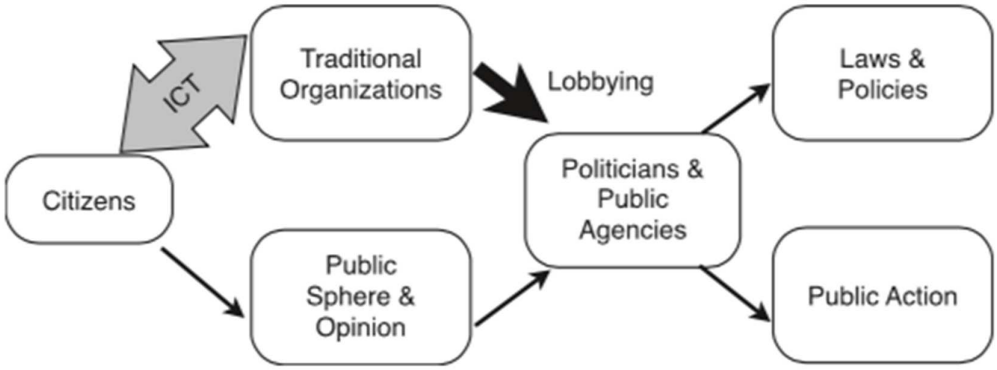

Figure 6. Mobilization Model. Based on Fung et al. (2013).

Political associations may be encouraged to take advantage of ICT methods for digital mobilization, as online platforms work best for goal-oriented, timely and concrete processes like political campaigning or protests. Democratic online campaigns are a recent phenomenon gaining much public attention and support; in addition, the ICT platforms benefit NGOs and other civil movements as they improve their structure, organization and effectiveness by gaining greater supporting audience (Fung et al., 2013).

Digitized self-organization may pose a threat to authoritarian governments having aspirations of political status quo, as citizens switch to difficult to regulate, *en masse* online communication rather than government-censored traditional media (Diamond, 2010). Based on this logic, ICT penetration should be somewhat regulated or limited in authoritarian countries where social unrest is likely.

2.3.4. Instruments for Controlling ICT Penetration. As a consequence of ICT as "liberation technology", the access and use of technology may be under control by governments in non-democratic regimes despite the infrastructure being present. The most

common instruments of ICT-induced connectivity control are either regulatory or technical. Restrictions involve internet content filtering, blocking international media, suppressed access to particular politically sensitive information online (Kerr, 2014). More extreme cases involve internet and ICT network cut offs during crises, such as in Egypt in 2011, slowing down internet speed, Iran in 2009, or imposing high costs or taxes for internet subscriptions to lower the amount of available users. Furthermore, some authoritarian regimes may limit the ICT infrastructure purposefully in order to keep control of particular segments of society (Kerr, 2014). Such measures may partly explain the discrepancies of ICT penetration among the regimes and authoritarian reaction to global ICT development and diffusion.

2.4. Dictatorship and ICT Penetration

While decentralized networking via ICT platforms may impose aforementioned threats to non-democratic regimes and encourage unwillingness for allowing greater penetration, some authoritarian countries, however, have managed to foster ICT-led development in the existing institutional settings (Kalathil & Boas, 2003; Kerr, 2014). Therefore it is essential to examine a different approach taken by authoritarian countries allowing for ICT penetration and determine the factors contributing to successful balancing of the “dictator’s dilemma”.

2.4.1. Decentralized System as Insufficient. As briefly introduced earlier, decentralized digital networking facilitated by ICT tools and platforms acts contrary to authoritative (also referred to as hierarchical) networking, where traditional, pre-ICT, communication methods (i.e. radio or television broadcast) are present rather than “many-to-many” communication (Singh, 2013). Openness to ICT access and use may encourage the flow of new information and put forward new forms of dialogue, which may be transformative. Citizens in authoritarian settings may learn how other states are run in terms of institutional designs and witness discrepancies in state-ensured freedoms worldwide via

ICT platforms making them question the current background and stimulate new meaning formation (Singh, 2013, see Figure 7). Moreover, as ICT may not only create new meanings but also mobilize and allow for dialogue and meaning circulation. The supporters of such argument believe ICT to have transformational power in destroying common authoritative patterns (Diamond, 2010; Fung et al., 2013; Singh, 2013). Hierarchical environment, in contrast to freely networked environment, strengthens existing structures by putting

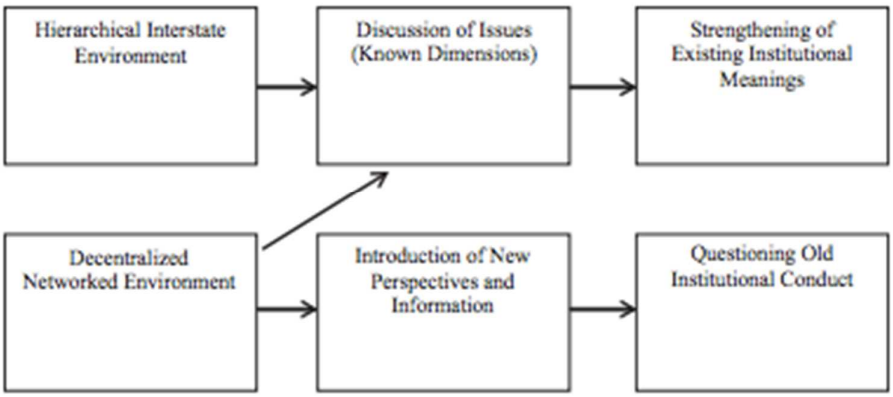

Figure 7. Meaning Formation in Different Environments. Based on Singh (2013).

constraints on new information and strengthening the existing meanings.

Despite the differences between hierarchical and decentralized networking frameworks, ICT-driven decentralized communication might as well prove ineffective as the new information obtained itself is not sufficient to transformative changes in society (Singh, 2013). Particular institutional settings may limit the information available or the authoritarian societies may be discouraged question the governing patterns. This overlap is displayed in Figure 7, where decentralized system of communication leads to discussion of limited (known) issues.

2.4.2. Overcoming Digital Dictator's Dilemma. This section considers conditions under which authoritarian regime and sufficient ICT access and use could coexist. Kalathil and Boas (2003) provide some important points on ICT as a mechanism of authoritarian support rather than threat. The authors consider benefits of ICT led economic development as

compatible with repressive regimes, which makes the “digital dictator’s dilemma” manageable or somewhat insignificant. Nevertheless, much depends on the region or individual countries. Based on that, authoritarian state involvement in ICT development is analyzed further in greater detail.

2.4.2.1. The state control and ICT absorption plans. Despite the economic benefits of ICT absorption and penetration, in authoritarian states the ICT diffusion is often led by governmental considerations expressed in terms of policies and technological controls (Kalathil & Boas, 2003). One of the main areas of control is the physical infrastructure, another is the strategic national plans of ICT introduction and penetration, which would serve authoritarian goals. Authoritarian countries witness the emulation among themselves regionally and worldwide in terms of promoting the best regime-serving Internet policy and ICT development plans. For example, Cuba is deeply engaged in analyzing China’s ICT policies and receiving support on how to apply the most efficient practices locally. Meanwhile, China aims at following Singapore’s example of balancing a high-tech, transparent and modern society with political and social regulations.

2.4.2.2 The state capacity and e-government. Critical part of ICT policy adoption success depends on state capacity on individual level. This is particularly the case of inefficient bureaucratic China or the states where leadership is divided and hesitation towards ICT policy implementation are present, like Vietnam. Other authoritarian states with strong vision, leadership or timely ICT policies, like Singapore or UAE, on the contrary, have demanded rapid ICT development and pursued ICT penetration control policies, which appeared highly efficient. Moreover, more efficient authoritarian states like Singapore and UAE have managed to develop e-government services and policies quicker and more willingly. Singapore is thus an example for both democracies and dictatorships on how to

provide e-services to citizens. Larger bureaucratic countries like China and Egypt, nevertheless, fail at changing the focus of bureaucracies to coordinate modern solutions.

Effective e-government programmes may as well improve authoritarian regime legitimacy in states where the government has generally provided extensive public services in return for political approval. However, much depends on the access to online services, which may result in discontent of e-government as elite prerogative. While this may not be the problem in Singapore, where government aims at promoting high standards of living for all via efficient e-government services, it may have an effect on UAE, where e-government service access is distributed unevenly comparing Dubai and other regions of the country.

2.4.2.3. The state propaganda and "soft power". ICT presence and absorption could potentially lead to strengthened regime position by the use of internet and social platforms as propaganda source. State-run traditional media may switch online and spread the ideological ideas in new advanced forms of communication. In addition, many authoritarian states use "soft power" as it proves to be an effective method of restriction. Self-censorship is a core part of the idea and the promotion of such behavior online has proven to be effective in China or Singapore. Indeed, creating such environment where citizens themselves comprehend politically sensitive content boundaries is a better tactic than controlling individual level social platform use (Kalathil & Boas, 2003).

2.4.2.4. The state and the opposition. Authoritarian states may benefit from increased ICT penetration as implemented methods of control may limit not only the sensitive content and communication but also the opposition's activities, as a result keeping the political status quo. As mentioned in subsection above, ICT may facilitate government propaganda and the spread ideological messages, which may discourage or completely limit the opposition parties' ability to compete. Kalathil & Boas (2003) suggest that Egypt's and Singapore's

political environment completely bans opposition campaigning via internet, which helps maintaining the monopoly of power of the ruling party.

2.4.3. Observations on the Public Status Quo. Particular aspects of the society may also contribute to stability of authoritarian regime even with if the provision of ICT tools is present. The first thing to take into account is that ICT and the internet are mainly the prerogative of elites or politically engaged businesses or organizations in many authoritarian environments. Elites may be unwilling to challenge the political status quo as they are in beneficial situation already. Also, even if ICT access and use spreads more widely among the public, the citizens may appear too risk-averse to actually engage in politically sensitive content in the new medium of information – the internet. Also, state-led propaganda online may grow as the penetration rates increase, or the public may become skeptical towards all media content, even the international one. This may explain why increasing ICT penetration in authoritarian states may not change the public opinion towards the regime and ICT penetration may not act as "liberation technology" per se.

The last thing to consider is that in some cases the approach towards political benefits of ICT is too optimistic. Citizens living in authoritarian regimes may seek for cross-border information via social capital – communicating with relatives living abroad or tourists, which is the primary source of shaping the public opinion in the state of Cuba rather than ICT (Kalathil & Boas 2003). Thus, when the society has other channels of information on cross-border or global affairs, the ICT may only contribute marginally if at all.

2.4.4. Prior Empirical Findings. In theory, the relationship between regime type and ICT diffusion seems logical and thought-through. Yet, empirical studies have not been extensive in a sense that in vast majority of studies regime type is treated as control, rather than independent variable. Despite the fact, results are in support of a significant effect (Baliamoune-Lutz, 2003; Wunnava & Leiter, 2009). Economic determinants of "digital

divide" are considered as superior, therefore, receive more recognition in terms of theoretical implications, extensive interpretation and are more scrutinized in empirical models. Studies by Baliamoune-Lutz (2003) and Wunnava & Leiter (2009) have incorporated Freedom House measure of democracy to analyze the effects on ICT diffusion levels.[3] Baliamoune-Lutz (2003) has reported political and civil rights being significant determinants of mobile cellular phone diffusion rates and the number of internet hosts. However, the number of internet users and personal computer diffusion is not significantly affected by democratization. Wunnava and Leiter (2009) conclude on positive and significant impact of democracy level on internet penetration.

2.5. Causal Mechanism Between Variables and Hypotheses

2.5.1. Assumptions. Two opposing ideas are discussed throughout the Chapter 2 – ICT access and use may or may not vary based on the regime type of a country. The assumptions of both sides of the debate are generalized below and pave the way for hypotheses' formulation.

Digital Dictator's Dilemma, reviewed in previous sections, poses a critical question of whether communication and information technologies should be available to all citizens universally in non-democracies (Kedzie, 1997; Kerr, 2014). The dilemma implies that the internet increases the number of message originators and receivers, thus making it difficult for dictators to manage compared to conventional communication tools of telephony and television (Kedzie, 1997). Moreover, ICT-driven enhancement of the public sphere, transparency boost and mobilization may have transformative effects raising concerns for authoritarian governments and potentially leading to political change (Fung et al., Singh,

[3] Baliamoune-Lutz (2003) measures civil and political liberties separately – using two indexes provided by Freedom House. Wunnava & Leiter (2009) use Freedom Index by Freedom House.

2013). Democracies, on the other hand, should embrace ICT, as it facilitates and fosters democratic governance further.

As reviewed in sections 2.6. and 2.7., the question arises whether the access to new information via ICT platforms actually allows for new meaning formation in authoritarian countries and is enough to start transformative societal changes (Singh, 2013). Authoritarian governments may find solutions (state control, capacity, "soft power", e-government apparatus, etc.) for coexistence of political status quo and an adequate ICT access and use within the economies (Kalathil & Boas, 2003). Additional thing to consider is that risk-averse character (known as "self-censorship") of the public in non-democratic regimes may also discourage use of ICT in potentially harming anti-government ways.

2.5.1. Hypotheses. Based on theoretical implications and prior empirical studies, the position taken further and tested is that the regime type should contribute to varying levels of ICT penetration rates. The corresponding hypotheses are constructed as follows:

Hypothesis 1 (H1): Countries with higher level of democracy have a higher level of ICT penetration;

Hypothesis 1a (H1a): Higher level of democracy contributes to a higher level of communication technology penetration;

Hypothesis 1b (H1b): Higher level of democracy contributes to a higher level of information technology penetration.

3. Empirical Research

After the theoretical considerations examined in the previous chapters, the relationship between democratization and ICT penetration is analyzed empirically. The aim of the third Thesis part is the examination of validity of hypotheses proposed. The section is structured as follows: in the first parts the data sample and operationalization of variables are presented, further sections include the models, data analysis and overall conclusions on the hypothesized relationships. The final section of the chapter includes limitations of the research and recommendations for upcoming ones.

3.1. The Sample

The data sample includes 34 countries of the regions of Middle East and North Africa (MENA) and East Asia and Pacific as specified by the World Bank (The World Bank, 2017). The complete list of countries could be found in the Appendix A. The reasoning behind such scope of countries involves some of the following theoretical considerations. Firstly, the availability of data concerning ICT penetration rates as well as the democratization level is sufficient as compared with the scarcity of data for Central Asia or Africa. Secondly, such sample provides reasonable variation among the independent variable of concern – democratization and others, such as income (summary statistics in the upcoming section demonstrates it numerically). The last reason for such sampling stems from the theoretical considerations as quite significant portion of the literature has investigated the ICT impact for societies during the Arab Spring, or ICT penetration and high-income aspects of semi-authoritarian Singapore in East Asia (Kalathil & Boas, 2003; Stepanova, 2011). The time period of consideration is 1990-2015, which means that the panel data is constructed of 34 cross-sections for the time period of 26 years. Any countries, which have missing values for the independent variable of democratization, are excluded from the sample despite being in the region of concern in order to achieve more reliable results and interpretation. Another

aspect of the sample is that in all four models considered it is unbalanced because of the different time periods of internet (broadband subscriptions) or mobile cellular phone introduction in the sample countries.

3.2. Variables

Theoretical assumptions are based on Digital Dictator's Dilemma, described in section 2.2. Four different models are employed in analyzing the democratization impact on telecommunications and internet penetration rates. This means that separate ICT indicators rather than combined ICT variable are treated as the dependent variables.

It is worth mentioning that the distinction between communication and information technologies has become obscure. Internet may not only account for information access but may as well be used as a tool for communication by various individuals and companies (Baliamoune-Lutz, 2003). Also, as the main tool for any personal communication is a fixed or wireless telephony, the mobile phone applications have granted the availability of information and data access via cellular telephony. Therefore, not only the variables including subscriptions are used, but also the variable of *Internet Users* is considered in addition to others, as it is equally a tool for communication and includes various gadgets for the internet use.

3.2.1. Models of ICT Penetration.

3.2.1.1. Model 1 & 2: Fixed and mobile telephony subscriptions. These two models involve voice communication on one to one basis based on fixed line and mobile telephone access and use. The dependent variables in these models are *Fixed telephone subscriptions (per 100 people)* and *Mobile cellular subscriptions (per 100 people),* both of which are sourced from International Telecommunication Union (ITU) reports and are also available on the World Bank database. The former variable refers to the total active fixed telephone lines available in a particular country, sum of subscriptions present and state payphones (World

Bank, 2017b). The latter variable includes all mobile telephony subscriptions that provide voice communication. Indicator includes both active postpaid and prepaid subscriptions of mobile phone accounts (World Bank, 2017c).

3.2.1.2. Model 3: Broadband subscriptions. This model considers the availability of internet. The dependent variable of concern is *Fixed broadband subscriptions (per 100 people)*, which includes subscriptions to high-speed internet with the speeds of 256 kbit/s or greater (World Bank, 2017d). The indicator covers fixed-broadband, satellite broadband and wireless broadband subscriptions for both individual and company use and excludes internet via mobile cellular telephony (World Bank, 2017d). The source of data for this variable is ITU and the World Bank.

3.2.1.3. Model 4: Internet users. The fourth model measures the usage of internet. In this case, the dependent variable is defined as *Internet users (per 100 people)* and measures the amount of individuals who have used the internet in the last year. The indicator includes a broader understanding of "use" than *Fixed broadband subscriptions*, as the "use" defined for *Internet users* may be via computers, cellphones, games machines, digital television and other means, i.e. gadgets (World Bank, 2017e). The ITU and the World Bank provide data values for the variable.

3.2.2. Independent Variable: Democratization Level.

The independent variable employed in the study is the Democratization level. In order to measure democratization of a given country Polity IV index is used, where a country's regime type is placed on a continuum scale ranging from strongly autocratic (-10) to strongly democratic (10) with 0 as a "neutral Polity score" (Marshall et al., 2016). The theoretical and empirical benefits of Polity IV measure of democracy are already considered in subsection 2.1.2. in the second chapter of the Thesis. Additionally, it is worthwhile mentioning here that standardized authority scores of -66, -77 and -88 referring to "foreign interruption",

"anarchy" and "transition" respectively, which are present in some country cases, are converted into missing values as proposed by Dataset User's Manual (Marshall et al., 2016). The dataset for the countries of interest is retrieved from the Center for Systemic Peace website (Center for Systemic Peace, 2017).

3.2.3. Control Variables.

Several socio-economic indicators are included as control variables in the models based on theoretical grounds and previous empirical studies examined in the literature review chapters. It is expected that financially liberalized pro-trade economic environment with significant levels of FDI and GNI should be characterized by liberalized, more accessible use of ICT goods and services. Moreover, it is anticipated that ICT penetration is an integral part of educated and literate society. Socio-economic control variables are operationalized in further sections.

3.2.3.1. Foreign direct investment. FDI impact is of great importance, as foreign affiliates may transfer high-tech, know-how or even managerial practices to local ones (Baliamoune-Lutz, 2003; Becchetti & Adriani, 2005). This is likely to translate horizontal (same industry), vertical (backward and forward linkages) and labour mobility (greater knowledge sharing) spillover effects (Keller, 2009). FDI is measured in terms of percentage of GDP and the data is retrieved form the World Bank (2017). The control variable is expected to hold a positive relationship with the dependent variable.

3.2.3.2. Income. Gross national income (GNI) is considered as a potential determinant of ICT use and access levels due to demand side characteristic by altering preferences of owning ICT goods and putting constraints on the budget (Baliamoune-Lutz, 2003; Chin & Fairlie, 2010). GNI adjusted for purchasing power parity data is provided in current US dollars and retrieved from the World Bank (2017g). The association between GNI and ICT indicators is expected to be positive.

3.2.3.3. Financial liberalization. Financial deepening is used as a variable representing financial liberalization or development and is considered as potential determinant of ICT penetration rates. The concept of financial deepening refers to an increase of financial sector size and its importance to the economy (Shah & Bhutta, 2014). As financial deepening increases, it puts pressure on banks to become one of the first adopters of ICT, as it provides them additional sources of revenue and value for customers in terms of accessibility (Baliamoune-Lutz, 2003). Thus, financial liberalization and technology use and access should be related positively. Financial deepening is measured by *Broad money as % of GDP* from World Bank database (World Bank, 2017h) following Baliamoune-Lutz (2003) study.

3.2.3.4. Openness to trade. As emphasized by variety of scholars, both the importing and the exporting activity of countries may lead to greater ICT adoption and spread (Baliamoune-Lutz, 2003; Kerr, 2009; Chin & Fairlie, 2010). Therefore, it is expected that openness to trade may increase the need for ICT infrastructure and consequential enhanced access and use. Openness is measured by *Trade as % of GDP* and sourced from World Bank dataset (World Bank, 2017i)

3.2.3.5. Literacy rate. One of the two potential social determinants of ICT accessibility is the literacy rate. It is expected that low levels of literacy may prevent ICT diffusion and limit the opportunities of ICT development. The dataset for Literacy rate is provided by United Nations and includes adults of age 15 and older (United Nations, 2017a). Due to unavailability of data for the period of concern, the value of 2015 is used as a constant for all countries throughout the sample.

3.2.3.6. Education. The last control variable of concern is education, referring to discrepancies between years of schooling and expected years of schooling among the sample countries. ICT adoption and diffusion requires not only a particular level of infrastructure but

the development of human capital as well, therefore, higher level of education is expected to facilitate ICT penetration. Due to the lack of time series data for education, a constant value of 2013 level of education is used for the dataset. The source of values is the composite value of Education in Human Development Index (United Nations, 2017b).

3.2.3.7. Additional variable considerations. Literature review has distinguished other potential determinants, such as pricing, infrastructure, English language proficiency and inequality. Due to the framework of the Thesis, the proxy for fixed-telephone subscription charges may not be reliable to assess the effect on other ICT indicators, which are intended to be kept the same throughout the models (refer to 1.4.5. Pricing). Alternative proxy could not be found for the time period of concern including all sample countries. Infrastructure with proxy of telephone landlines may be insufficient in explaining internet usage, as already touched upon in 1.4.6. Infrastructure subsection (Wunnava and Leiter, 2009). English language proficiency is not considered in the models as well due to lack of empirical support (Caselli & Coleman, 2001; Skaletsky et al., 2016). Inequality is excluded from data analysis based on the argument of Baliamoune-Lutz (2003), as described in 1.4. Determinants of ICT Penetration Levels, and lack of data on spatial inequality for the sample countries.

3.3. Regression Equations

Aforementioned variables are a part of regression equations used for building econometric models for the analysis. Equations are described below.

Model 1: Mobile cellular subscriptions:

$$mobile_t = \beta_0 + \beta_1 \times DEMO_t + \beta_2 \times FDI_t + \beta_3 \times GNI_t + \beta_4 \times FL_t + \beta_5 \times TL_t + \beta_6 \times EDU_t + \beta_7 \times LIT_t + \varepsilon;$$

Model 2: Fixed telephone subscriptions:

$$telephone_t = \beta_0 + \beta_1 \times DEMO_t + \beta_2 \times FDI_t + \beta_3 \times GNI_t + \beta_4 \times FL_t + \beta_5 \times TL_t + \beta_6 \times EDU_t + \beta_7 \times LIT_t + \varepsilon;$$

Model 3: Fixed broadband subscriptions:

$broadband_t = \beta_0 + \beta_1 \times DEMO_t + \beta_2 \times FDI_t + \beta_3 \times GNI_t + \beta_4 \times FL_t + \beta_5 \times TL_t + \beta_6 \times EDU_t + \beta_7 \times LIT_t + \varepsilon$;

Model 4: Internet users:

$users_t = \beta_0 + \beta_1 \times DEMO_t + \beta_2 \times FDI_t + \beta_3 \times GNI_t + \beta_4 \times FL_t + \beta_5 \times TL_t + \beta_6 \times EDU_t + \beta_7 \times LIT_t + \varepsilon$, where

$mobile_t$ = mobile cellular subscriptions (per 100 people), values range: $0 < mobile_t \leq 100$, in some cases may exceed 100;

$telephone_t$ = fixed telephone subscriptions (per 100 people), value range: $0 < telephone_t < 100$;

$broadband_t$ = fixed broadband subscriptions (per 100 people, value range: $0 < broadband_t < 100$;

$users_t$ = internet users (per 100 people), value range: $0 < users_t < 100$;

$DEMO_t$ = Polity IV index of democracy, value range: $-10 \leq DEMO_t \leq 10$, expected $\beta_1 > 0$;

FDI_t = foreign direct investment as % of GDP, expected $\beta_2 > 0$;

GNI_t = gross national income adjusted for purchasing power parity, expressed in current U.S. dollars, expected $\beta_3 > 0$;

FL_t = financial liberalization, measured by broad money as % of GDP, expected $\beta_4 > 0$;

TL_t = trade liberalization, measured by the total sum of exports and imports as % of GDP, expected $\beta_5 > 0$;

EDU_t = difference between mean years of schooling and expected years of schooling, value range: $0 < EDU_t < 1$, expected $\beta_6 > 0$;

LIT_t = literacy rate as % of population above 15 years old, expected $\beta_7 > 0$; $mobile_{t-1}$,

ε = error term.

3.4. Panel Data Analysis

In order to test the underlying hypotheses panel data analysis is performed. Gretl software is employed for such purpose. The process together with the results of analysis is described in the upcoming sections and appendices.

The primary consideration is the normality of the variables in use for the data analysis. Four tests of normality yield identical results with the p-values lower than 0.05 or, simply put, the rejection of normality hypothesis. Logarithmic and squared value transformations are performed on each variable, however, neither method leads to improvements of the normality. For this reason the analysis is proceeded with initial data values. Summary statistics of all non-transformed variables could be found in Appendix B.

Several models – Pooled Ordinary Least Squares (OLS) together with Fixed and Random Effects are considered for testing the validity of hypotheses. Panel diagnostics of OLS is performed based on Joint significance of differing group means, Breusch-Pagan and Hausman test statistics. Model comparisons tests are performed for four regression equations highlighted in 3.3. and described in depth further.

3.4.1. Model 1: Mobile Cellular Subscriptions. The first model of investigation tests the effect of independent and control variables on mobile cellular penetration. P-values retrieved throughout all three panel diagnostic tests suggest that Fixed Effects model should be relied on and used for interpretation of findings (for precise figures refer to Appendix C). However, there are some aspects raising concern – Fixed Effects model shows a non-normal distribution of residuals, whereas Wald test implies heteroskedasticity in errors. Both tests reflect bias towards estimators. In order to account for non-constant variance (heteroskedasticity) in the error terms, robust standard errors, Arellano, is used for the proposed model. An alternative issue of collinearity is tested and with the values falling below 10 it is concluded that the problem does not occur. Tests on normality of distribution,

heteroskedasticity, collinearity and specification may be found in Appendix D. Final table for model comparison is provided below.

Table 1.

Model 1: Mobile Cellular Subscriptions. Model Table for Comparison.

	Pooled OLS	**Fixed-Effects (RSL)**	**Random-Effects**
const.	35.0815 (17.0057) [0.0395]**	−96.7079 (22.8021) [0.0002]***	106.6 (32.89) [0.0012]**
FDI	1.16559 (0.435959) [0.0077]***	0.862570 (0.679299) [0.2133]	1.177 (0.4204) [0.0053]**
DEMO	0.788799 (0.297199) [0.0081]***	2.50537 (1.36831) [0.0764]*	1.958 (0.4750) [0.0000]**
INCOME	0.00123955 (9.05715e-05) [1.27e-37]***	0.00348931 (0.000948174) [0.0009]***	0.002013 (0.0001395) [0.0000]**
FL	0.228416 (0.0383223) [4.14e-09]***	0.892942 (0.217743) [0.0003]***	0.5679 (0.06045) [0.0000]**
TL	0.0221342 (0.0332347) [0.5057]	0.118406 (0.220719) [0.5954]	0.06929 (0.05326) [0.1937]
EDU	−33.4132 (22.3357) [0.1352]		-139.0 (42.89) [0.0013]**
LIT	−0.131433 (0.253310) [0.6040]		-0.7034 (0.5058) [0.1648]
N	654	695	654
Adjusted R^2	0.3473	0.5432	-
Akaike crit.	6907.81	6864.41	6962.62
lnL	-3396	-3394	-3473

As it can be observed from the Table 1, Fixed Effects model with robust standard errors has the highest R^2 of 54.32% together with the highest log likelihood of -3394 and the lowest Akaike value of 6864.41. This contributes to the panel diagnostics recommendation of using this model for hypothesis testing. With regards to the variables, the strongest predictors

of mobile cellular subscriptions are economic – such as income and financial liberalization, both suggesting a positive, expected direction of an effect. Democratization appears to have a statistically significant positive effect on mobile cellular subscriptions as well, however, the confidence interval in the Fixed Effects within 10% confidence interval.

Further checking for robustness involves of differentiation of same variables and examination of whether the same relationships hold true. The findings indicate that among all three models the only significantly positive variable is FDI (Appendix E), which suggests that its effect on mobile phone penetration is robust, whereas interpretation of income effect, which changes its direction, should be interpreted in the cautious manner. Democratization appears as no longer significant as well.

3.4.2. Model 2: Fixed Telephone Subscriptions. A second model tests the effect on democratization on subscriptions of fixed telephones. Panel diagnostics in this case recommends using Random Effects (see Appendix C). The same issues appear as in the previous model – non-normal distribution and heteroskedasticity are present however, there is no collinearity between variables (Appendix D). The table for model comparison is as provided below.

Table 2.

Model 2: Fixed Telephone Subscriptions. Model Table for Comparison.

	Pooled OLS	**Fixed-Effects**	**Random-Effects**
const.	-16.49 (3.122) [0.0000]**	4.882 (0.9217) [0.0000]**	-20.81 (12.57) [0.0982]*
FDI	-0.08260 (0.08000) [0.3022]	0.03533 (0.04327) [0.4146]	0.02659 (0.04308) [0.5373]
DEMO	0.1561 (0.05456) [0.0044]**	0.1926 (0.07066) [0.0066]**	0.1666 (0.06751) [0.0139]**
INCOME	0.0001550	3.146e-05	5.498e-05

	Pooled OLS	**Fixed-Effects**	**Random-Effects**
	(1.663e-05)	(2.649e-05)	(2.395e-05)
	[0.0000]**	[0.2355]	[0.0221]**
FL	0.08468	0.1092	0.1017
	(0.007030)	(0.01044)	(0.009608)
	[0.0000]**	[0.0000]**	[0.0000]**
TL	0.01140	0.005645	0.008167
	(0.006102)	(0.009838)	(0.009084)
	[0.0621]*	[0.5663]	[0.3690]
EDU	69.45		64.44
	(4.103)		(16.29)
	[0.0000]**		[0.0001]**
LIT	-0.2480		-0.1569
	(0.04657)		(0.1982)
	[0.0000]**		[0.4288]
N	653	653	653
Adjusted R^2	0.6846	0.9310	-
Akaike crit.	4582.59	3646.55	4647.48
lnL	-2283	-1787	-2316

Random Effects model demonstrates the economic determinants of income and financial liberalization as statistically significant. In addition, democratization and education appear as having a positive and statistically significant effect on fixed telephone subscriptions not only in proposed model but also throughout all three. Considering the model fit, Fixed Effects model with the R^2 of 93.1%, log likelihood of -1787 and Akaike value of 3646.55 demonstrates the best fit in comparison with Random Effects or Pooled OLS. Nevertheless, Random Effects with a bit poorer fit should be referred to when analyzing the relationships.

The differentiation is performed in order to highlight the most meaningful effects. The results are in contrast to those observed in models with variables in levels (see Appendix E). After differencing no significant effects of any variable are observed among all three models. This suggests that results obtained may not be robust.

3.4.3. Model 3: Fixed Broadband Subscriptions. The third model aims at testing the effects of democratization on fixed broadband subscriptions. Very low p-values among panel diagnostic tests infer relying on Fixed Effects model for the analysis. Other tests suggest non-

constant variance of residuals, not normal distribution and absence of collinearity (more precise representation in Appendix D). Preferred Fixed Effects model, thus, is adjusted for robust standard errors, Arellano. The obtained models are in Table 3.

Table 3.

Model 3: Fixed Broadband Subscriptions. Model Table for Comparison

	Pooled OLS	**Fixed-Effects (RSE)**	**Random-Effects**
const.	-11.77 (3.469) [0.0008]**	−22.7031 (5.57764) [0.0003]***	10.76 (8.906) [0.2276]
FDI	-0.1379 (0.07472) [0.0658]*	−0.150122 (0.0993350) [0.1408]	-0.1441 (0.06155) [0.0197] **
DEMO	0.1542 (0.05743) [0.0076] **	−0.0594264 (0.170090) [0.7292]	0.1505 (0.1024) [0.1424]
INCOME	6.112e-05 (1.581e-05) [0.0001] **	0.000386029 (0.000131059) [0.0061]***	0.0002497 (2.695e-05) [0.0000] **
FL	0.05304 (0.006554) [0.0000] **	0.173339 (0.0396442) [0.0001]***	0.1393 (0.01273) [0.0000] **
TL	0.01476 (0.005873) [0.0124] **	0.0425591 (0.0314844) [0.1862]	0.02428 (0.01044) [0.0206] **
EDU	26.29 (4.328) [0.0000]**		-8.719 (10.63) [0.4127]
LIT	-0.07007 (0.04813) [0.1463]		-0.2195 (0.1300) [0.0920] *
N	386	405	386
Adjusted R^2	0.4701	0.5152	-
Akaike crit.	2516.13	2277.66	2757.39
lnL	-1250	−1101.83	-1371

Economic indicators of income and financial liberalization appear as the strongest predictors of internet subscriptions with positive and statistically significant (5% confidence interval) coefficients. This is perceived throughout all compared models. Democratization,

however, has a significantly negative effect in Pooled OLS and Random Effects models but shows no significance in recommended Fixed-Effects model. This model in comparison to others provides the highest values of R^2 and lnL with corresponding values of 51.52% and -1101.83, which supports the recommendation for use.

Differentiation is considered for robustness check and the corresponding model table is provided in Appendix E. Of the two mentioned above, only the effect of financial liberalization on Internet subscription is perceived as robust after the differentiation. Income loses its significance, therefore, the effect must be evaluated and interpreted with extreme cautiousness.

3.4.4. Model 4: Internet Users. The last model tests the hypothesized relationship between democratization and the amount of internet users. Panel diagnostic tests display p-values below 0.05 and indicate relying on Fixed Effects model (precise values in Appendix C). Robust standard errors of Arellano are used for the recommended model due to non-normal distribution of residuals and issue of heteroskedasticity. RESET test for model specification suggests no specification error (see Appendix D). Comparison of the three models is shown below in Table 4.

Table 4.

Model 4: Internet Users. Model Table for Comparison

	Pooled OLS	**Fixed-Effects (RSE)**	**Random-Effects**
const.	2.499 (7.660) [0.7444]	−55.1035*** (7.90544) [6.76e-08]	32.54** (15.28) [0.0337]
FDI	-0.3406* (0.1899) [0.0734]	−0.647470*** (0.224162) [0.0069]	-0.4414** (0.1783) [0.0136]
DEMO	0.3201** (0.1316) [0.0153]	0.484788 (0.305735) [0.1227]	0.6401** (0.2098) [0.0024]
INCOME	0.0005820**	0.00157610***	0.0009585**

	Pooled OLS	**Fixed-Effects (RSE)**	**Random-Effects**
	(3.862e-05) [0.0000]	(0.000373127) [0.0002]	(6.091e-05) [0.0000]
FL	0.2067** (0.01645) [0.0000]	0.470170*** (0.0677120) [7.29e-08]	0.3709** (0.02642) [0.0000]
TL	0.04583** (0.01405) [0.0012]	0.0959412 (0.105712) [0.3709]	0.07437** (0.02356) [0.0017]
EDU	3.216 (9.574) [0.7371]		-54.57** (19.67) [0.0057]
LIT	-0.1647 (0.1114) [0.1396]		-0.3570 (0.2345) [0.1285]
N	586	623	586
Adjusted R^2	0.5259	0.7695	-
Akaike crit.	5063.15	4722.15	5246.16
lnL	-2524	−2325.07	-2615

The proposed Fixed Effects model highlights income and financial liberalization as statistically significant determinants of the amount of internet users (corresponding p values of 0.0002 and 7.29e-08) with anticipated positive directional effect. Net inflows of FDI fall into 5% significance region as well, however, the effect on the dependent variable is of the opposite direction to what was assumed beforehand. Regarding the model fit, Fixed Effects model demonstrates the best model fit based on the highest values of R^2 (76.95%) and log likelihood (-2325.07) and the lowest Akaike (4722.15). This confirms that the panel diagnostic tests are consistent.

Robustness check performed by differentiating the variables is provided in Appendix E. The data show that only democratization has a significant effect on the number of internet users when applying generous p-value of 0.1 in Fixed Effects model and p-value of 0.05 in Random and Pooled OLS models. The direction of the effect, however, is unanticipated as the coefficient next to democratization index is negative. While the strongest effects are, in theory, when the direction and the significance remain the same after the differentiation, the

interpretation of results in this case must take into account such change of signs in the variable.

3.5. Interpretation of Findings

3.5.1. Impact of Democratization on Communication Technology. The first two models, Model 1 and Model 2, which reflect mobile cellular and fixed telephone subscriptions, were used in testing the hypothesis H1a - the democratization effect on communication technology penetration. Initial regression equations are now transformed as follows based on the recommended panel diagnostic test in each case:

$$mobile_t = -96.7079 + 2.50537 \times DEMO_t + 0.862570 \times FDI_t + 0.00348931 \times GNI_t + 0.892942 \times FL_t + 0.118406 \times TL_t + \varepsilon;$$

$$telephone_t = -20.81 + 0.1666 \times DEMO_t + 0.02659 \times FDI_t + 0.00005498 \times GNI_t + 0.1017 \times FL_t + 0.008167 \times TL_t + 64.44 \times EDU_t - 0.1569 \times LIT_t + \varepsilon.$$

The summary of regression coefficients, their significance and robustness is shown in the following Tables 5 and 6. This is the basis for interpretation of findings and hypothesis testing. Further subsections include the analysis of each observed predictor and its effect on the number of mobile cellular and fixed telephone subscriptions.

Table 5.

Regression Equation: Mobile Cellular Model

Predictor	Coefficient	P-value	Significance	Robust after differencing?
const.	−96.7079	0.0002	*** (1% confidence)	
DEMO	2.50537	0.0764	* (10% confidence)	no
FDI	0.862570	0.2133		yes
INCOME	0.00348931	0.0009	*** (1% confidence)	no
FL	0.892942	0.0003	***(1% confidence)	no
TL	0.118406	0.5954		no

Table 6.

Regression Equation: Fixed Telephone Model

Predictor	Coefficient	P-value	Significance	Robust after differencing?
const.	-20.81	0.0982	*(10% confidence)	
DEMO	0.1666	0.0139	**(5% confidence)	no
FDI	0.02659	0.5373		no
INCOME	0.00005498	0.0221	**(5% confidence)	no
FL	0.1017	0.0000	**(5% confidence)	no
TL	0.008167	0.3690		no
EDU	64.44	0.0001	**(5% confidence)	no
LIT	-0.1569	0.4288		no

3.5.1.1. Democratization level. In both, Mobile Cellular and Fixed Telephone models democratization appears as a statistically significant determinant of the number of subscriptions (p-values of 0.0764 and 0.0139, respectively). The direction of the impact is positive in the models as expected in H1a. The coefficient of Democratization in Mobile Cellular Model suggests that as Polity IV index goes up by one point (a country is classified as more democratic), the amount of mobile cellular subscriptions per 100 people increases by roughly 2.5. Corresponding coefficient in Fixed Telephone Model implies that as a country is more democratized, as measured by Polity IV index, the number of fixed telephone subscriptions per 100 people grows by 0.17. The findings, however, are not robust as confirmed by differentiation but sufficient enough for not rejecting the H1a hypothesis.

3.5.1.2. Foreign direct investment. FDI in the models appears as negligible – the sign next to the coefficient is positive as anticipated, however, statistically insignificant (p-values of 0.2133 and 0.5373 correspondingly in the models). This contributes to the analysis of Baliamoune-Lutz (2003), as the author's data analysis found no support towards FDI impact on ICT diffusion. Likewise, in this study, there is no support that FDI has an effect on the rise in communication technology subscriptions.

3.5.1.3. Income. Gross national income (per capita, PPP) is considered as a statistically significant determinant of communication technology penetration with 1% confidence in Mobile Cellular Model and 5% confidence in Fixed Telephone. Tables 5 and 6 demonstrate that an increase in GNI by 1000 US dollars would lead to additional 3.49 subscriptions of cellphones per 100 people, whereas the same amount of dollars would increase fixed telephone subscriptions by 0.05. It is worth highlighting that after differentiation income variable changes its sign, which suggests that the relationship may not be robust and puts limitation on findings.

3.5.1.4. Financial liberalization. Coefficients next to financial liberalization variable and their significance show that financial sector has a positive and statistically significant impact on cellphone and fixed telephone subscriptions. 1% growth in financial sector is expected to increase mobile phone subscriptions per 100 people by 0.86, while the same growth adds 0.10 fixed telephone subscriptions per 100 people.

3.5.1.5. Trade liberalization. The last economic variable referring to openness to trade is statistically insignificant in both communication technology models, with the p-values of 0.5954 and 0.4288, respectively. The signs of the coefficients suggest a positive effect – the more % of GDP the trade consists of, the more subscribers of cellular and fixed phones should exist.

3.5.1.6. Education. Education is statistically significant in Model 2 (p-value of 0.0001) and has a positive impact on number of fixed telephone subscriptions. This implies that an increase of 1% of mean years and expected years of schooling ratio leads to additional 64.44 subscriptions per 100 people. The results, however, are not robust in the models of first differences.

3.5.1.7. Literacy rate. The coefficient next to the adult literacy variable suggests statistically insignificant negative effect on fixed telephone subscriptions. It may be

interpreted as follows: as the adult literacy rate rises by 1%, the fixed telephone subscriptions per 100 people drop by roughly 0.16. This contributes to the findings of Baliamoune-Lutz, as the same negative trend was reported. The reasoning behind is that the use of telephony does not demand subscribers to be literate – as merchants from MENA or South Asia despite being illiterate are able to manage their businesses via such mean of communication (Baliamoune-Lutz, 2003).

3.5.2. Impact of Democratization on Information Technology. Models 3 and 4 aimed at analyzing the effect of regime type on information technology in terms of access (subscriptions of broadband) and internet use. Regression equations and tables with significance levels and coefficients are used for testing IT penetration part of ICT described in H1b. Final regressions of fixed broadband subscriptions and internet users are demonstrated next:

$$broadband_t = -22.7031 - 0.0594264 \times DEMO_t - 0.150122 \times FDI_t + 0.000386029 \times GNI_t + 0.173339 \times FL_t + 0.0425591 \times TL_t + \varepsilon;$$

$$users_t = -55.1035 + 0.484788 \times DEMO_t - 0.647470 \times FDI_t + 0.00157610 \times GNI_t + 0.470170 \times FL_t + 0.0959412 \times TL_t + \varepsilon.$$

Predictors of internet access and use are summarized in detail in Tables 7 and 8 together with their coefficients, significance levels and results of robustness check. The results are obtained from panel diagnostic tests, in this case – Fixed Effects models. Following the example of communication models, IT models are analyzed further in depth together with including subsections of each predictor separately.

Table 7.

Regression Equation: Fixed Broadband Model

Predictor	Coefficient	P-value	Significance	Robust after differencing?
const.	−22.7031	0.0003	***(1% confidence)	
DEMO	−0.0594264	0.7292		no
FDI	−0.150122	0.1408		no
INCOME	0.000386029	0.0061	***(1% confidence)	no
FL	0.173339	0.0001	***(1% confidence)	yes
TL	0.0425591	0.1862		no

Table 8.

Regression Equation: Internet User Model

Predictor	Coefficient	P-value	Significance	Robust afterdifferencing?
const.	−55.1035	0.0000000676	***(1% confidence)	
DEMO	0.484788	0.1227		yes
FDI	−0.647470	0.0069	***(1% confidence)	no
INCOME	0.00157610	0.0002	***(1% confidence)	no
FL	0.470170	7.29e-08	***(1% confidence)	no
TL	0.0959412	0.3709		no

2.5.2.1. Democratization level. As it can be approached from regression equation table for broadband subscriptions, democratization has a negative effect on the number of subscribers. As Polity IV index goes up by one point, the amount of broadband subscriptions per 100 people decreases by roughly 0.06. This is contrary to the hypothesis, however, may imply that more democratized countries switch from fixed broadband, which works through phone lines or cables, to portable mobile broadband, providing flexible on-the-go access (Lee, Marcu & Lee, 2011). Meanwhile, democratization impact on the number of internet users is positive as anticipated (see Table 8). Both models imply insignificant results due to high p-values of 0.7292 for fixed broadband and 0.1227 for internet users. This leads to rejection of H1b claiming that democratization should lead to higher IT penetration rates.

2.5.2.2. Foreign direct investment. Regression equations for IT models indicate a negative effect of FDI inflows as percent of GDP on the number of broadband subscriptions and internet users. However, only in the latter model the coefficient is statistically significant. The direction of the effect is not as expected but may deliver some important insights. The directional effect is analysed in more detail in subsection 2.5.3.

2.5.2.3. Income. Gross national income is a significant and positive determinant of IT indicators. Fixed broadband model implies that growth of GNI per capita adjusted for purchasing power parity by 1000 USD may lead to 0.39 subscriptions per 100 people, whereas internet user model shows that the same GNI translates into 1.8 users per 100 people. The findings, however, are not robust.

2.5.2.4. Financial liberalization. Regressions in Tables 7 and 8 show a positive and statistically significant relationship between financial liberalization and internet access and use. Financial sector growth of 1% leads to roughly 0.17 additional fixed broadband subscribers per 100 people while the same growth results in an increase of internet users by roughly 0.47 per 100 people. The results of financial deepening impact on fixed broadband subscriptions remain robust after differentiation – it suggests a strong relationship.

2.5.2.5. Trade liberalization. Trade liberalization is seen to have a positive though statistically insignificant impact on IT indicators (p-values are 0.1862 and 0.3709 in Model 3 and 4 respectively). This implies that general exporting and importing activities are not sufficient in determining IT access and use. Further researchers could focus on trade of ICT composing parts between upstream and downstream industries within countries as this could bring new and/or different insights on the relationship.

2.5.3. Concluding Remarks. Throughout all 4 tested models a clear trend is present – ICT penetration rates seem to depend on the economic criteria, gross national income of a country, and financial criteria, development of financial sector. This echoes the findings of

Baliamoune-Lutz (2003), which highlighted income effect on ICT diffusion and also other studies considering the benefits of knowledge-economy and rise in productivity due to increased access and use of ICT (Becchetti & Adriani, 2005; Papaioannou & Dimelis, 2007). Interestingly enough, FDI is seen as insignificant in all models apart from Internet User model. As for models which provide no support for FDI impact on ICT, the argument could be that most countries may receive FDI targeted at labour-intensive industries rather than ICT-driven ones (exceptions in the sample, however, could include Singapore or South Korea) (Baliamoune-Lutz, 2003). Another control variable, openness to trade, has also no significant effect on ICT subscriptions and use throughout all 4 models. Based on Chinn & Fairlie (2006) insignificant relationship may be due to including other variables, which incorporate the regulatory or legal environment of a country (in context of the Thesis, democratization variable accounts for the regulatory environment) – as significant effects of trade liberalization were obtained mainly in studies not accounting for regulatory or legal environment. Such unanticipated outcome may also be explained due to the composition of trade variable – the measure incorporates overall trade rather than trade in ICT goods and services.

As for the hypothesis testing, H1a hypothesis is not rejected. Based on the findings of Model 1 and 2, the impact of democratization on communication technology penetration is positive and statistically significant. This implies that democracies are more likely to have both – higher fixed telephone and mobile cellular subscriptions than dictatorships. Such relationship may refer to dictatorial fear of loss of autonomy, as more message originators should be present due to an increase in telephony subscriptions and signify the need to minimize the means of expression (Kedzie, 1997).

H1b hypothesis is rejected because of insignificant effect of democracy on fixed broadband subscriptions as well as on the number of internet users. Income and financial

liberalization appear as stronger determinants of IT penetration rates rather than the regime type. This may infer that in case of “digital dictators dilemma”, economic benefits may go together with regime status quo - the measures might be taken for making internet regime-friendly (Kerr, 2014). Dictatorial regimes may adopt and promote regime-serving internet policies and create development plans, thus not liming the access but restricting it in terms of content filtering or national, rather than global, intranet (Kalathil & Boas, 2003). Other arguments of the same authors may be that the non-democratic regimes may use internet as soft power in a sense of displaying particular political messages or develop a “self-censorship” – the environment where citizens themselves avoid particular sensitive topics and materials online.

In general, democratization effect on ICT penetration is ambiguous – confirmed on communication technology level but not with respect to information technology. Therefore, H1 is partially not rejected. Composed ICT variable could be a solution for joint hypothesis testing as referring to Bacchetti & Adriani (2005) study on ICT penetration effect on growth and productivity levels, however, it is out of scope of this Thesis.

3.6. Limitations and Recommendations

The first limitation of the study arises from the dataset itself – from econometric perspective the issues appear because of unbalanced dataset, also all models have non-normal distribution with non-constant error variance. Heteroskedasticity was taken into account by Arellano robust standard errors. Non-normal distribution mainly came from different internet/mobile cellular phone introduction rates of countries in the sample, therefore, cannot be fixed without taking shorter time periods common to all sample countries. Ramsey’s RESET test implies specification errors – a probable omission of variables. Further studies could consider adding pricing of ICT goods and services to regressions because it could affect the demand side of ICT as in related literature mixed results prevail (Dasgupta, Lall &

Wheeler, 2005; Chinn & Fairlie, 2010), or as previously mentioned, operationalizing trade in a different manner.

Regarding the model fit, the explained variation is above 50% in all models. Coefficients of determination reflect greatly upon previous studies of Baliamoune & Lutz (2003), Chinn & Fairlie (2010) and are a bit lower than in Dasgupta et al. (2005) study as per relatively different operationalization of the dependent variables. Nevertheless, despite quite acceptable model fit in the models and significance of coefficients, the robustness check does not support democratization as a significant predictor of ICT penetration levels in either of the models for the regions in the sample. Other studies could consider greater samples of countries, perhaps the ones including more variation in the independent variable, in order to recheck for robustness and attain greater generalizability of findings.

Additional consideration may be the framework of accounting for effect of democratization. The regime change itself may not pose immediate and direct effect, therefore, future research could consider measuring democratization in more depth, i.e. in terms of separate variables, such as legal, regulatory environment, or the quality of institutions. This could provide greater insights into what may hinder or foster ICT penetration. On the dependent variable level, combined ICT variable could be used instead of separate ICT indicator models. Such operationalization would be beneficial in terms of accounting for ICT on the whole rather than “information plus communication technology” separately, thus, clearer interpretation of findings.

Conclusion

The purpose of the Thesis was to analyse effects of democracy on penetration rates of several ICT indicators. Vast majority of literature distinguishes positive outcomes of increased ICT usage – mainly the productivity gains, economic growth and progressing towards the knowledge economy (Becchetti & Adriani, 2005; Papaioannou & Dimels, 2007; Vinnychuk et al., 2014; Kaur & Singh, 2016; Moshiri, 2016). The contemporary concept of "digital divide" – the growing gap between technology have and have-nots has caught the attention of many scholars and put forward the need for further examination of the factors constituting disparities among economies (Selwyn, 2004; Min, 2010). Despite the prominent highlights on socio-economic predictors of variation in ICT access and use, democracy level appeared as an underlying non-economic determinant, which is not fully exploited empirically.

The hypotheses implied that democracies are more likely to have higher levels of ICT penetration (H1) and is subdivided into two secondary hypotheses – firstly, the democracies should have greater levels of communication technology use (H1a), secondly, IT use for such regime type should as well be greater (H1b). The hypothesized relationship was constructed after the review of implications of the regime type on ICT spread and vice versa. "Digital dictator's dilemma" has laid theoretical foundations for empirical testing, whereas three models of ICT and regime type interaction were modelled as arguments behind hypothesis, demonstrating how ICT tools may enhance the public sphere, mobilize the citizens and allow for political action (Kedzie, 1997; Fung et al., 2013).

The empirical analysis of panel data included 34 countries for the time period of 1990-2015. Four models were tested, as different ICT indicators were employed as dependent variables - mobile cellular phone, fixed telephone and fixed broadband subscriptions with the fourth being internet users. Proposed fixed-effects and random-effects models implied

throughout all four models the significant and positive effect of gross national income per capita and financial liberalization on ICT penetration. In terms of “digital dictators dilemma” this may imply that economic and financial concerns outweigh the fear of loss of political status quo, or the adequate means of ICT content filtering are available in non-democracies. Contrary to the expectations, FDI and trade openness are seen as insufficient for explaining the penetration rates of ICT indicators.

Regarding the hypothesis testing, H1a, which was based on communication models, was not rejected. The results implied that higher democracy levels are associated with higher fixed telephone and mobile cellular subscriptions, moreover, the coefficients were statistically significant. H1b, which considered the effects of the regime type on IT, was rejected. Democratization had no significant effect on the number of fixed broadband subscribers, neither on the internet users. Based on this, H1 is only partially not rejected.

The Thesis had advanced the field of research on ICT in terms of focusing on a non-socioeconomic predictor of ICT penetration rates, but political one. The results suggested that democratization level might partially contribute to the digital divide. Moreover, framework of the study has allowed for drawing conclusions on how theoretical concept of “digital dictator’s dilemma” works throughout a particular data sample.

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Appendix A

Country List

Middle East and North Africa:

Algeria
Bahrain
Djibouti
Egypt
Iran
Israel
Iraq
Jordan
Kuwait
Lebanon
Libya
Marocco
Omar
Qatar
Saudi
Arabia
Syria
Tunisia
UAE
Yemen

East Asia and Pacific:

Japan
China
Cambodia
Indonesia
Korea
Lao
Malaysia
Mongolia
Myanmar
Papua New
Guinea
Philipines
Singapore
Thailand
Timor
Vietnam

Appendix B

Summary Statistics

Variable	Mean	Median	Min.	Max.	Std. Dev.	C.V.	Skewness	Ex. kurtosis	Missing obs.
Mobile Cellular Subscriptions	43.7818	16.3401	0.00000	231.763	52.2579	1.19360	1.00302	-0.130539	12
Fixed Broadband Subscriptions	5.31496	1.37473	0.00000	40.2499	8.43603	1.58722	2.05552	3.50969	414
Fixed Telephone Subscriptions	14.1536	9.51395	0.0343920	61.5741	14.3224	1.01192	1.32954	0.952300	14
Internet Users	18.8552	6.88170	0.00000	93.4783	24.8974	1.32045	1.39400	0.796480	136
FDI	3.30088	1.95588	-5.28819	43.9121	4.75017	1.43906	3.10769	14.4704	70
Democratization	-1.75692	-3.00000	-10.0000	10.0000	6.59343	3.75284	0.458318	-1.29427	53
Income	17390.0	8425.00	460.000	138480.	22487.8	1.29314	2.39514	6.29879	100
Financial Liberalization	74.6619	60.1910	4.89446	262.179	49.5135	0.663170	1.42671	1.94403	58
Education	0.602361	0.615720	0.305878	0.864510	0.138300	0.229597	-0.303147	-0.422808	0
Literacy	88.6156	93.9000	64.2000	100.000	10.2161	0.115286	-0.931822	-0.445590	52
Trade Openness	93.7551	82.0762	0.0209992	439.657	62.4014	0.665579	2.58828	9.30538	73

Appendix C

Panel Diagnostics for Models 1-4

Table C1

Panel Diagnostics for Mobile Cellular Subscriptions

Test	P-value	Model determination
Joint significance of differing group means	4.66854e-61	Fixed effects
Breusch-Pagan test	1.42323e-13	Random effects
Hausman test	2.01455e-49	Fixed effects

Table C2

Panel Diagnostics for Fixed Telephone Subscriptions

Test	P-value	Model determination
Joint significance of differing group means	5.74872e-183	Fixed effects
Breusch-Pagan test	0	Random effects
Hausman test	0.34138	Random effects

Table C3

Panel Diagnostics for Fixed Broadband Subscriptions

Test	P-value	Model determination
Joint significance of differing group means	5.04971e-66	Fixed effects
Breusch-Pagan test	1.50607e-105	Random effects
Hausman test	4.15977e-19	Fixed effects

Table C4

Panel Diagnostics for Internet User Subscriptions

Test	P-value	Model determination
Joint significance of differing group means	1.46022e-63	Fixed effects
Breusch-Pagan test	4.50845e-50	Random effects
Hausman test	1.87422e-37	Fixed effects

Appendix D

Normality Test, Wald Test, RESET Test, VIF estimates for Models 1-4

Model 1: Mobile Cellular Subscriptions

Test	Null hypothesis	Test Statistic	P-value	Conclusion
Test for normality of residual	Error is normally distributed	Chi-square (2) = 164.196	2.21427e-36	Non-normal.
Distribution free Wald test for heteroskedasticity	Common error variance of unit roots	Chi-square(31) = 3823.63	0	Heteroskedastic.
RESET test for specification	Specification is adequate	F(2, 644) = 51.8881	1.27877e-21	Specification error.
Variance Inflation Factors	VIF>10 indicates multicollinearity problem.	FDI 1.542 DEMO 1.325 INCOME 1.605 FL 1.314 TRADE 1.672 EDU 2.611 LITERACY2.197		Not collinear.

Model 2: Fixed Telephone Subscriptions

Test	Null hypothesis	Test Statistic	P-value	Conclusion
Test for normality of residual	Error is normally distributed	Chi-square(2) = 98.3035	4.50462e-22	Non-normal.
Distribution free Wald test for heteroskedasticity	Common error variance of unit roots	Chi-square(31) = 88641.2	0	Heteroskedastic.
RESET test for specification	Specification is adequate	F(2, 643) = 222.676	3.3006e-74	Specification error exists.
Variance Inflation Factors	VIF>10 indicates multicollinearity problem.	FDI 1.542 DEMO 1.325 INCOME 1.605 FL 1.314 EDU 2.611 LITERACY2.197 TRADE 1.672		Not collinear.

Model 3: Fixed Broadband Subscriptions

Test	Null hypothesis	Test Statistic	P-value	Conclusion
Test for normality of residual	Error is normally distributed	Chi-square(2) = 42.1892	6.89828e-10	Non-normal.
Distribution free Wald test for heteroskedasticity	Common error variance of unit roots	Chi-square(29) = 295071	0	Heteroskedastic.
RESET test for specification	Specification is adequate	F(2, 376) = 62.3887	4.00057e-24	Specification error exists.
Variance Inflation Factors	VIF>10 indicates multicollinearity problem.	FDI 1.542 DEMO 1.325 INCOME 1.605 FL 1.314 EDU 2.611 LITERACY2.197 TRADE 1.672		Not collinear.

Model 4: Internet Users

Test	Null hypothesis	Test Statistic	P-value	Conclusion
Test for normality of residual	Error is normally distributed	Chi-square(2) = 23.074	9.76202e-06	Non-normal.
Distribution free Wald test for heteroskedasticity	Common error variance of unit roots	Chi-square(31) = 29896.4	0	Heteroskedastic.
RESET test for specification	Specification is adequate	F(2, 576) = 0.109207	0.896563	No specification error.
Variance Inflation Factors	VIF>10 indicates multicollinearity problem.	FDI 1.542 DEMO 1.325 INCOME 1.605 FL 1.314 EDU 2.611 LITERACY2.197 TRADE 1.672		Not collinear.

Appendix E

Models 1-4 in First Differences: Robustness Check

E1

Model 1: Mobile Cellular Subscriptions, First Differences

	Pooled OLS	Fixed-Effects	Random-Effects
const.	5.808**	5.923**	6.091**
	(0.3802)	(0.3740)	(0.6729)
	[0.0000]	[0.0000]	[0.0000]
d_FDI	0.1717*	0.1680*	0.1685*
	(0.1008)	(0.09817)	(0.09777)
	[0.0892]	[0.0876]	[0.0853]
d_DEMO	-0.1569	-0.1294	-0.1389
	(0.2596)	(0.2537)	(0.2524)
	[0.5458]	[0.6101]	[0.5824]
d_INCOME	-0.0002091	-0.0003824*	-0.0003117
	(0.0001904)	(0.0002014)	(0.0001950)
	[0.2724]	[0.0581]	[0.1105]
d_FL	0.05750	0.04716	0.05261
	(0.05343)	(0.05384)	(0.05312)
	[0.2822]	[0.3815]	[0.3223]
d_TL	-0.003092	-0.0006357	-0.0005288
	(0.03310)	(0.03284)	(0.03252)
	[0.9256]	[0.9846]	[0.9870]
N	**618**	**618**	**618**
Adjusted R^2	**0.0093**	**0.1123**	**-**
Akaike crit.	**4418.72**	**4410.89**	**4419.43**
lnL	**-2203**	**-2169**	**-2204**

E2

Model 2: Fixed Telephone Subscriptions, First Differences

	Pooled OLS	Fixed-Effects	Random-Effects
const.	0.1938**	0.1942**	0.1844**
	(0.06206)	(0.06149)	(0.09222)
	[0.0019]	[0.0017]	[0.0459]
d_FDI	0.0009261	0.0006684	0.0009371
	(0.01645)	(0.01613)	(0.01604)
	[0.9551]	[0.9670]	[0.9534]
d_DEMO	-0.009583	-0.01037	-0.01054
	(0.04234)	(0.04169)	(0.04140)
	[0.8210]	[0.8036]	[0.7991]
d_INCOME	1.963e-05	2.363e-05	2.039e-05
	(3.105e-05)	(3.309e-05)	(3.164e-05)
	[0.5275]	[0.4755]	[0.5194]

	Pooled OLS	Fixed-Effects	Random-Effects
d_FL	0.01062	0.008987	0.009154
	(0.008728)	(0.008850)	(0.008683)
	[0.2242]	[0.3103]	[0.2921]
d_TL	-0.002056	-0.001919	-0.002031
	(0.005405)	(0.005397)	(0.005324)
	[0.7038]	[0.7223]	[0.7030]
N	**616**	**616**	**616**
Adjusted R^2	**0.0032**	**0.0938**	**-**
Akaike crit.	**2170.46**	**2233.67**	**2170.53**
lnL	**-1079**	**-1050**	**-1079**

E3

Model 3: Fixed Broadband Subscriptions, First Differences

	Pooled OLS	Fixed-Effects	Random-Effects
const.	0.6658**	0.7126**	0.646480***
	(0.07766)	(0.07058)	(0.126693)
	[0.0000]	[0.0000]	[3.35e-07]
d_FDI	-0.01420	-0.008275	−0.00995026
	(0.02172)	(0.01953)	(0.0195201)
	[0.5137]	[0.6721]	[0.6102]
d_DEMO	-0.07062	-0.03815	−0.0477905
	(0.06123)	(0.05625)	(0.0558751)
	[0.2496]	[0.4982]	[0.3924]
d_INCOME	2.254e-05	-1.759e-05	−7.05654e-06
	(3.119e-05)	(3.059e-05)	(2.98670e-05)
	[0.4704]	[0.5658]	[0.8132]
d_FL	0.03240**	0.02334**	0.0255790***
	(0.01013)	(0.009482)	(0.00937582)
	[0.0015]	[0.0143]	[0.0064]
d_TL	0.002305	-0.0002011	0.000436973
	(0.006632)	(0.006159)	(0.00610174)
	[0.7284]	[0.9740]	[0.9429]
N	**351**	**351**	**351**
Adjusted R^2	**0.0334**	**0.2888**	**-**
Akaike crit.	**1192.11**	**1140.39**	**1194.10**
lnL	**-590.1**	**-536.2**	**−591.05**

E4

Model 4: Internet Users, First Differences

	Pooled OLS	Fixed-Effects	Random-Effects
const.	2.539**	2.659**	2.58243***
	(0.1660)	(0.1585)	(0.248918)
	[0.0000]	[0.0000]	[3.24e-25]
d_FDI	-0.03871	-0.02489	−0.0312363
	(0.04584)	(0.04321)	(0.0436287)
	[0.3988]	[0.5648]	[0.4740]
d_DEMO	-0.2500**	-0.2014*	−0.219265**
	(0.1117)	(0.1063)	(0.106936)
	[0.0256]	[0.0586]	[0.0403]
d_INCOME	7.725e-05	-5.262e-05	5.89010e-06
	(7.827e-05)	(8.040e-05)	(7.83239e-05)
	[0.3241]	[0.5131]	[0.9401]
d_FL	0.01517	-0.007801	0.00268839
	(0.02320)	(0.02269)	(0.0225993)
	[0.5135]	[0.7312]	[0.9053]
d_TL	0.01206	0.01165	0.0117422
	(0.01565)	(0.01509)	(0.0150967)
	[0.4416]	[0.4403]	[0.4367]
N	**536**	**536**	**536**
Adjusted R^2	**0.0141**	**0.1768**	**-**
Akaike crit.	**2856.408**	**2819.73**	**2857.51**
lnL	**-1422**	**-1374**	**−1422.76**